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FACULTY OF COMMERCE

Dissertation in fulfilment of the degree of Master of Philosophy (Management Studies)

**Examining the presence of anchoring and adjustment in stock
market investment decisions**

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Abstract

With three major stock market crashes in less than two decades, understanding the forces at work in the modern stock market is more important than ever before. The anchoring and adjustment heuristic has often been described as one of the psychological forces influencing investment decisions but little research has been done to support this belief. The aim of the present dissertation is to empirically study the presence of anchoring and adjustment in stock market decisions. To do this, a small group of equity analysts from South African investment firms were used for a pilot study before a survey was presented to a sample of 295 fourth year actuarial and finance students from the University of Cape Town. An experimental research design was used with a salient peak or trough on a share chart (the anchors) as the independent variable and participants' estimates of a firm's fundamental value as the dependent variable.

No significant relationship between the anchor and participants' estimates of fundamental value was found. More specifically, the research results suggested that participants experienced an anchoring effect but were debiased before providing an estimate of fundamental value. This is believed to have occurred due to the inclusion of multiple salient anchors in the research materials consistent with the nature of information available to analysts in real-world investment decision-making contexts. As these findings contradict those of most studies in anchoring and adjustment, it is recommended that more research is conducted on the relationship between the anchoring bias and stock market decisions in realistic investment settings. Additional research is also needed to clarify the effect that multiple anchors have on the anchoring bias.

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Stefan Els

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1. Introduction

The anchoring and adjustment heuristic (or mental shortcut) was first identified by Tversky and Kahneman in 1974. According to their theory, when making an estimate, people anchor on a relevant or salient value and then adjust this value to reach a final answer (Tversky & Kahneman, 1974). Anchoring and adjustment allows individuals to quickly produce reasonably accurate estimates to difficult questions (Gilovich, 2002). However, using mental shortcuts can also lead to systematic biases. Specifically, it was found that people adjust the anchor insufficiently to account for the difference between the anchor and the required value (Tversky & Kahneman, 1974). This leads to estimates which are systematically biased towards the anchor value (Plous, 1993). This bias is exacerbated when individuals anchor on irrelevant but highly salient values (Chapman & Johnson, 2002) such as past share prices in the stock market (Mussweiler & Schneller, 2003).

The anchoring bias has been studied in relation to various topics in behavioural economics, including advertising (Chandrashekar & Grewal, 2006; Wansink, Kent, & Hoch, 1998), consumer preferences (Ariely, Lowenstein, & Prelec, 2003) and stock market investing (Marsat & Williams, 2009; Mussweiler & Schneller, 2003). The present study will focus on the effect that the anchoring bias has on share valuations.

1.1 Research problem

The anchoring and adjustment heuristic is often described in investing literature as a psychological bias which stock market investors should be aware of (see Anufriev & Hommes, 2007; Bhandari, Hassanein, & Deaves, 2008; Buseti, 2009). However, very few studies have directly investigated the impact of anchoring and adjustment on investors (Marsat & Williams, 2009; Mussweiler & Schneller, 2003), and no study to date has been conducted with a sufficiently large sample. Instead, literature on the topic has tended to either infer the presence of the anchoring bias from its presence in other populations (for example, Buseti, 2009), or to rely on small student samples to draw their conclusions (for example, Kaustia, Alho & Puttonen, 2008; Mussweiler & Schneller, 2003). Furthermore, it is felt that research to date has not provided participants with sufficient information to make educated decisions, forcing participants to rely more strongly on heuristics. The purpose of the present study is therefore to investigate the presence of the anchoring bias in investors while making use of a large sample and providing participants with the information needed to make informed decisions. This purpose leads directly to the present study's research question:

Does the anchoring and adjustment heuristic affect investment decisions?

As the purpose of the present study is to either confirm or deny the existence of anchoring and adjustment as a potential bias affecting investment decisions, the focus is placed on decisions made in a realistic (but simulated) investment environment rather than on abstract judgements. This allows the research to focus on improving investor behaviour without making inferences from unrelated fields.

One secondary question will be investigated by the present paper: Are investors affected by anchors which they consider irrelevant? This question will allow the researcher to determine whether the bias is caused by the subconscious use of the anchor or by a belief in the validity of the anchor.

1.2 Purpose of the study

In the wake of one of the biggest financial crises since the great depression (Pendery, 2009), and the third major stock market crash in as many decades, improving the tenuous grasp that economists have on the psychology of investing is crucial. Investigating the anchoring bias allows economists and social scientists to not only confirm or disprove the existence and prevalence of such biases, but also provides investors with methods of mitigating the effects of these biases. This may prove to be a difficult task, however, as research by Chapman and Johnson (2002) has shown that anchoring is a remarkably robust phenomenon. As such, it is important to not only understand the anchoring phenomenon, but also the processes that cause it. With this in mind, this study has the following three purposes:

1. To explore the presence of anchoring and adjustment in investment decisions.
2. To determine whether an anchoring effect will occur in a realistic simulated investment environment.
3. To examine whether participants who consider the anchor uninformative will still display an anchoring effect.

Answering these questions will provide future researchers with empirical evidence on which to base further research, including research on the ways in which the anchoring bias can be moderated in investment situations. Furthermore, examining the way in which investors react to anchors they consider relevant and irrelevant will enrich our understanding of the anchoring mechanisms and processes.

1.3 Structure of the dissertation

The dissertation will begin with the literature review. Because of the complexity of the anchoring bias, it is important that the literature on anchoring and adjustment is understood before the research method is discussed. The literature review will include sections on the

historical context of anchoring and adjustment, how anchoring works, its characteristics and limitations, how anchoring relates to investors, and finally, how anchoring could potentially be debiased in an investment context.

The literature review will be followed by an in-depth look at the research method that was used for the dissertation. The research method section will examine the research design and hypotheses, how the sample was obtained and how the data were gathered and analysed. It will conclude with a brief discussion of the ethical considerations of the experiment.

Following the research method will be a section on the results and findings. In this section, the data will be analysed and conclusions will be drawn. The findings will also be discussed and compared with other research in the field, and the implications of the findings will be investigated. The dissertation will be concluded with recommendations for future research.

2. Literature review

2.1 Introduction

According to Blaikie (2010), the purpose of the literature review is to provide “background to and context for the research and to establish a bridge between the project and the current state of knowledge on the topic” (p. 68). For Marshall and Rossman (2010) the purpose of the literature review is to “refine and redefine the research questions by embedding them in larger traditions of inquiry” (p. 39).

Building on these definitions, the goals of the present literature review are fourfold: First, the literature review aims to provide a conceptual and theoretical framework for the research question (Roberts, 2010). Doing so will allow readers to critically analyse the present research. Second, the literature review aims to clarify anchoring and adjustment by presenting the literature in an organised and concise fashion that guides the reader through this confusing and often contradictory field. Third, the literature review will aim to show links and highlight relationships between anchoring and adjustment and investors. Much research has been done on investors and on anchoring and adjustment separately, but very little on how anchoring and adjustment affects investors. As such, correlations with research inside and outside of anchoring and adjustment will be drawn to show the potential impact of anchoring on investors. Finally, it is a goal of the literature review to cast light on further avenues of exploration and questions that need to be answered.

The aim of this literature review is thus to provide a clear but broad framework that brings to light connections between disparate fields of research. Consistent with the exploratory nature of the study, these connections will pave the way for future research while simultaneously providing a context for the present research questions.

In order to best achieve these goals, the literature review examines the literature in broad strokes with only select articles being analysed in detail. The dynamic and contested nature of anchoring and adjustment research makes a broad overview of anchoring research the most impartial approach to the literature review. By focusing the review on too few articles the researcher risks presenting a one-sided perspective on a multi-faceted process (Epley, 2004).

To ensure that the overview is comprehensive, emphasis is placed on understanding the implications of the literature rather than on specific findings. The continually changing understanding of anchoring processes has led to a continuous change in the interpretation of findings, making a strict analysis of findings ineffectual. Furthermore, due to the fine distinction between different anchoring mechanisms (brought on by methodological differences; see Epley & Gilovich, 2001) the research method used is an important part of each study and will be discussed where relevant.

The literature is discussed under four primary headings: History and context, anchoring and adjustment, investors and debiasing.

In the first section, history and context, the paradigmatic assumptions of anchoring and adjustment are examined. The history and context are discussed chronologically, starting with the rational choice theory, continuing through bounded rationality and concluding with Tversky and Kahneman's (1974) work on heuristics and biases. More than just providing readers with an understanding of the origins and historic context of anchoring and adjustment, this topic examines important distinctions between the *economic man* and a heuristic and biases conception of investors.

The second section focuses on literature specific to anchoring and adjustment. As this topic forms the bulk of the literature review, it is divided into four subsections. The first subsection looks at the psychological mechanisms of anchoring and adjustment. Many different anchoring mechanisms have been suggested and research into the anchoring processes is ongoing (for a summary, see Chapman & Johnson, 2002). This will be followed by a review of research on the categorization of anchors. The present study makes use of a distinction between self-generated, externally-provided, and basic anchors and the literature review will investigate these categories in more detail. The third subsection looks at the characteristics of anchoring, specifically focusing on the robustness and durability of anchoring effects. These characteristics have significant implications for investors which will be examined in the text. In the final subsection, the limitations and boundary conditions of anchoring are investigated. As there are multiple mechanisms that produce an anchoring bias, very few limitations have consistently been shown in anchoring research. As such, this subsection will

examine the conditions affecting the strength of the anchoring effect.

In the third topic, the research on anchoring and adjustment is applied to investors. The topic starts by briefly looking at the characteristics of the investment environment relevant to anchoring. Following this will be a detailed review of all the research directly linking anchoring and adjustment and investing. This is followed by a broader look at studies in finance-related fields, such as negotiations and consumer pricing. The investor topic is concluded by examining potential anchors in the investment environment.

The final topic looks at the possibility of mitigating the anchoring bias in investment situations. While most experiments have failed to debias anchoring and adjustment (Epley, 2004), there is evidence from within and outside of anchoring research that suggests that the anchoring bias might be overcome in specific situations. These techniques, and their practical use in an investment environment, will be discussed in the debiasing topic.

At this point it is important to reiterate that the literature review will focus almost exclusively on the psychological underpinnings of anchoring and how anchoring and adjustment affects investment decision making. The literature review will not examine the financial effects of the anchoring bias. While these are certainly important and accordant with the present study's goal of improving financial decision making, it is beyond this study's scope.

2.2 History and context

2.2.1 The origins of heuristics and biases

Since the seminal work by Tversky and Kahneman (1974) on heuristics and biases, researchers have made use of heuristics to explain biased behaviour in a wide range of settings. In order to understand the foundations of such research, as well as its limitations, it is important to take a brief look at the history of economics leading up to heuristics and biases. Central to the development of the heuristics and biases approach are the theories of rational choice and bounded rationality: Rational choice theory formed, and still forms, the basis of most economic decision making theories while the theory of bounded rationality caused a shift from a purely rational theory of decision making to a behavioural theory of decision making.

2.2.1.1 Rational choice theory

Rational choice theory is the most commonly used framework for understanding economic behaviour. Central to it is the economic person—an entity assumed to be perfectly rational at all times (Simon, 1955). The economic person is assumed to weigh up the benefits and costs of their behaviours before choosing the behaviour with the greatest utility. As such, the maximisation of utility is the central precept of economic rationality (Blume & Easley, 2007)

and thus of rational choice theory.

Rational choice theory makes three important assumptions about individuals and the decisions they make: (1) Each decision has a limited number of options available which are all known to the rational person (Simon, 1955, 1987); (2) the rational person has a stable and logically consistent set of preferences (Mas-Collel, Whinston, & Green, 1995); and (3), the rational individual can rank all alternatives available to him or her according to these preferences. The rational person thus makes consistent decisions based on the expected value of the subjective utility of the available actions. These assumptions do not imply that people always make the best decisions but rather that people always make rational decisions after attempting to weigh up all possible alternatives. Mistakes occur, but they occur because people make unsystematic errors in weighing up the rewards and risks inherent in their actions (Gilovich, 2001). Even with this constraint, however, rational choice theory remains unrealistic as both a measure and description of human decision making.

One criticism of rational choice theory is that there is a lack of evidence supporting the conscious weighing up of options it assumes, especially in situations of complexity (Simon, 1955). Experiments in which rational choice theory was explicitly tested failed to support a strict adherence to rational decision making procedures (Leontief, 1971). An even stronger criticism questions the assumptions fundamental to rational choice theory. The assumption of choice consistency—that a similar environment would lead to a similar behaviour—contains a distinct possibility that much of what is “within the skin of the biological organism” (Simon, 1955, p. 101) is defined as part of the environment. Changes in the mood or motivation of an organism can lead to distinct changes in behaviour, changes which cannot be explained by stable and consistent preferences (Jones, 1999). This is underscored by preference shifts that occur due to minor alterations to the environment such as the order in which alternatives are presented (i.e. framing effects; Kahneman & Tversky, 1983). Such preference shifts are not in accordance with the assumed consistency of people’s choices.

A further problem is that models of “unbounded rationality,” such as the rational choice model, assume unlimited search (Gigerenzer & Todd, 1999). In models of unbounded rationality people continue searching until an optimal solution is found. This is only feasible when there are few alternatives available and becomes unrealistic when there are a large number of alternatives (for example, choosing how much money to invest in which stocks). Considering all alternatives in complex situations can be incredibly time consuming which makes it impossible in situations with time constraints. *Optimisation under constraints*, a later decision making theory, hypothesised that people first determine the optimal amount of resources, including time, to expend on a search before beginning the search (Gigerenzer & Todd, 1999). However, it has been shown that this may require even more cognitive

resources than an exhaustive search (Vriend, 1996). As such, rational choice theory's description of searches is fundamentally flawed.

Unbounded rationality further assumes that individuals have perfect knowledge regarding the opportunities available to them and the outcomes of their behaviours (Simon, 1989; Stoböner, 2008). This is a questionable assumption even in simple situations (Simon, 1997). A mundane task such as choosing a chocolate bar to purchase would require knowledge of all chocolate bars manufactured in the world. While many of these options can intuitively be discarded (such as chocolate bars sold in another city or country), the advantages and disadvantages involved in purchasing these bars can only be weighed up if the options are known. To complexify the decision making process further, optimal solutions are often unknowable in everyday situations (Simon, 1987).

As these criticisms highlight, rational choice theory provides a normative theory of decision making but fails to include the limitations of human decision making. Even more problematic is that it fails to describe how people really think (Gigerenzer & Todd, 1999). As such, rational choice theory has difficulty accurately describing and predicting behaviours in everyday decision making. Simon concludes that "actual human rationality-striving can at best be an extremely crude and simplified approximation to the kind of global rationality that is implied" (Simon, 1955, p. 101).

2.2.1.2 Bounded rationality

Bounded rationality attempts to remedy the problems of rational choice theory by including the decision maker's shortcomings (Simon, 1997). Simon (1947) argues that, in contrast with rational choice theory, there are practical limits to human rationality which are determined by the individual's environment. This argument signifies a distinct shift away from the comprehensively rational position of rational choice theory.

Environmental factors and cognitive limitations form the two pillars of bounded rationality research. Because the mind has certain limitations, decision makers make use of shortcuts to handle most tasks (Simon, 1990). Heuristic research attempts to determine what these shortcuts are and when they are used. However, as the heuristic chosen (and its suitability) depends on the structure of the environment (Simon, 1956), the environment is as important as the cognitive limitation.

While bounded rationality excelled at explaining why deviations from strictly rational behaviour occur, the question of how a search is stopped when little structure exists remained. To answer this, Simon (1956) proposed a stopping rule called *satisficing* (a word combining satisfy with suffice; Mankletow, 2000). According to the satisficing rule, individuals continue searching for a solution until they find one that meets a minimum level of

satisfaction. To determine what level of satisfaction they should be content with, people rely on their experience (Simon, 1990). There are multiple advantages to using satisficing as a stopping rule: (1) it allows decisions to be made when there are an undefined number of options; (2) it allows a decision to be made when the question has so little structure that all alternatives would need to be examined to determine the best solution; and (3) it allows a decision to be made when the available choices differ on more than one dimension (Simon, 1990). When alternatives have differences on multiple dimensions, a decision is made once an option which is satisfactory on all the dimensions is found.

Bounded rationality thus argues that perfect rationality is an unrealistic standard for humans (Simon, 1957). Instead, theories of decision making need to take the limitations of the human mind, as well as the characteristics of the environment, into consideration. Heuristics and biases research developed based on these principles with the aim of investigating the limitations of the human mind and how these limitations lead to biases.

2.2.2 Heuristics and biases

Heuristics and biases research examines how heuristic use leads to systematic biases (Gilovich, 2001). The following section will briefly look at the definition of heuristics and biases, criticisms of the heuristics and biases research direction and the relevance of heuristics and biases to economics and finance.

2.2.2.1 Definition of heuristics and biases

Langley (2004) calls heuristics rules of thumb that allow people to simplify complex computational tasks which would normally be too difficult. Epley (2004) refers to heuristics as mental shortcuts which are used when problems are exceedingly difficult, while Mussweiler and Epstude (2009) emphasise the way in which heuristics “transform complex tasks into simple judgements” (p. 2). The different definitions of heuristics all highlight that heuristics are simple tools used to answer complex questions, but they also suggest why heuristics go hand in hand with biases—as with all shortcuts, there is a risk that the shortcut will not be efficient. It is for this reason that behaviour sometimes deviates from the rules of perfect rationality: When the environment is ill-adapted to the heuristic being used, actual behaviour differs from rationally intended behaviour, and bounded rationality ‘shows through’ (Gigerenzer & Todd, 1999; Jones, 1999).

It is important to note that with heuristics and biases, the error made is not random or unsystematic. Instead, similar situations and experiences result in similar mistakes. Heuristics thus represent a qualitatively different style of thinking which results in systematic, predictable biases (Gilovich, 2001). The predictability of errors is what makes it meaningful to study the characteristics of, and the processes behind heuristics.

2.2.2.2 Principles of heuristics and biases model

Five principles of the heuristic and biases model can be identified: First, heuristics are not irrational. Instead, they are sensible decision making strategies which work in a different way from purely rational decision making processes. Simon (1947) describes human decision making as intendedly rational, as the purpose of heuristics is to make rational decisions in complex situations of uncertainty.

Second, although heuristics are designed to give quick and simple answers, they do so by using complex processes which are already in place (Gilovich, 2001). These complex processes often occur outside of conscious awareness, making them resistant to change (Wilson, Houston, Etling & Brekke, 1996). This becomes very important when searching for ways to mitigate or remove the bias.

Third, heuristics are not only used when faced with excessively difficult situations. Instead, heuristics are incorporated in everyday decision making (Gilovich, 2001).

Fourth, heuristics research has both a positive and a negative agenda. The positive agenda is to examine and describe how people make decisions in difficult and uncertain situations. The negative agenda of heuristic research is to discover the situations and conditions in which heuristic use deviates from the rules of probability (Gilovich, 2001). Finding the conditions under which bias occurs (and exceptions to these conditions) allows researchers to obtain a better understanding of human decision making.

Finally, heuristic use can be either automatic or deliberate (Gilovich, 2001). Because of their ability to simplify complex decisions, heuristics are often used consciously.

2.2.2.3 Conditions for heuristic use

Judgement under Uncertainty: Heuristics and Biases is the title of both the first article (Tversky & Kahneman, 1974) and the first book on heuristics and biases (Kahneman, Slovic, & Tversky, 1982). The title stresses the first, and most important, condition for heuristic use: uncertainty. Almost all research to date has focused on how participants make judgements when outcomes are uncertain. This makes intuitive sense, as participants who already know the answer to a question will rely on their memory, not heuristics, to obtain it. However, the exact effect of uncertainty on heuristic use is complex.

In research on anchoring and adjustment, Wilson et al. (1996) found that the more certain participants were about an answer the less likely they were to be influenced by heuristics. A contrasting study found that familiarity with a situation (Wright & Anderson, 1989) and expertise (Englich & Mussweiler, 2001; Northcraft & Neale, 1989) had little effect in diminishing the anchoring effect. In fact, these factors increased subjective feelings of

certainty without improving accuracy (Englich, Mussweiler, & Strack, 2006). A rule of thumb proposed by Simon (1999) is that knowledge and expertise do not lead to optimal solutions but rather to solutions that are better than average.

Other conditions required for heuristic use have been investigated (for example, Strack & Mussweiler, 1997), but these conditions are typically heuristic-specific. As such, the only shared condition for heuristic use is uncertainty.

2.2.2.4 Representativeness, availability, and anchoring

In their seminal research article, Tversky and Kahneman (1974) discuss three heuristics which can be identified through the biases they result in: Anchoring, availability, and representativeness.

The representativeness heuristic is used to answer probability questions regarding the categorisation of an object (Tversky & Kahneman, 1974), for example, what is the probability that *object A* (Johan) is part of *class B* (artist)? According to the representativeness heuristic, these judgements are based on how representative *object A* is of *class B*. The more *A* is representative of *B*, the higher the probability is judged to be. While it is an effective shortcut for making probability assessments, representativeness often leads to substantial errors because it ignores factors that should influence these assessments such as the base rate, sample size, and predictability of the target.

The availability heuristic is used when people judge the frequency or probability of an event occurring based on the ease with which occurrences of it spring to mind (Tversky & Kahneman, 1974). This is an effective strategy in most situations, as occurrences of large classes are easier to recall. However, the availability of information is affected by factors other than its frequency (such as the salience of the information), which leads to systematic biases.

The third heuristic identified in the research paper, and the focus of the present dissertation, is the anchoring and adjustment heuristic. When people make numeric estimates, they rely on highly salient or relevant numbers as starting points which they then adjust toward the final answer (Tversky & Kahneman, 1974). Bias occurs because the adjustments from the anchor are usually insufficient which results in answers that are skewed towards the anchor. As will be argued in the section on investors, anchors abound in the investment environment. When investors anchor on irrelevant anchors (such as a salient past share price) it could lead to biased decision making.

2.2.2.5 Criticisms of heuristics and biases

Despite its success at showing biased decision making, or perhaps because of it, the

heuristic and biases movement has been criticised fiercely by researchers from both inside and outside of decision making research. Understanding the criticisms and the context of these criticisms is important if the present research is to avoid the same criticisms.

One of the most common early criticisms of heuristics and biases research is that it paints the human mind in an overly negative light (Cohen, 1981; Einhorn & Hogarth, 1981; Lopes, 1991). This goes directly against what is believed by many scientists in the heuristics and biases movement. For example, Gilovich (2002) states that heuristics are adaptive tools in most situations. However, most heuristics and biases research chooses to focus on situations where heuristics are not adaptive because these situations best reveal the underlying cognitive processes.

A second criticism often made is that heuristics and biases are parlour tricks with little impact outside of the laboratory (Berkley & Humphreys, 1982; Hogarth, 1981). In a series of articles, Gigerenzer argues that the biases shown in the research of Kahneman and Tversky are cognitive illusions that only occur in laboratories. To support this statement, Gigerenzer makes the following points:

1. Subjective probabilities cannot be used to diagnose judgements as biased because subjective probability is an unresolved topic among statisticians. As such, there can be no normative standard with which answers can be compared (Gigerenzer, 1991).
2. Heuristic research disregards context and the way in which problems are represented (Gigerenzer, 1993; Gigerenzer, Hell, & Blank, 1988).
3. Errors of judgement disappear when questions are asked as frequencies (Gigerenzer, 1991).
4. Errors of judgement disappear when the role of random sampling is emphasised (Gigerenzer, 1991).
5. Heuristics are vague and largely undefined. Because of this, they can be applied to explain almost any behaviour (Gigerenzer, 1991, 1996).
6. Errors cannot be said to occur in a between-subjects design where no one individual is shown to deviate from his or her 'unbiased' answer (Gigerenzer, 1996).

Kahneman and Tversky (1996) rebut the first four criticisms by highlighting studies contradicting Gigerenzer's claims regarding the prevalence and pervasiveness of heuristics and biases (for example Grether, 1993; Slovic, Fischhoff & Lichtenstein, 1982; Tversky & Kahneman, 1973, 1974). As many biases had been shown in circumstances that Gigerenzer hypothesised would make them disappear, these criticisms are not significant.

The fifth criticism focuses on the lack of a formal definition for the representativeness and availability heuristics. As Gigerenzer (1991) focuses primarily on representativeness, Kahneman and Tversky (1996) do the same. While Kahneman and Tversky effectively argue that representativeness does not need a formal definition, this lack of formal definitions for most heuristics has hampered research in the anchoring and adjustment heuristic. The vagueness of anchoring's definition has led to a wide array of phenomena being categorised as anchoring and adjustment (Epley, 2004), and characteristics from one form of anchoring being erroneously applied to a different form of anchoring.

For the final criticism, Kahneman and Tversky (1996) concede that research on heuristics and biases has depended on between-subjects designs, especially in cases where there is a formal probability rule to compare judgements to. However, since these deviations represent a systematic deviation from a normative standard, they require explanation, regardless of whether any single decision can be shown to be biased or not.

2.2.2.6 Relevance to economics and finance

As shown by some of the criticisms, heuristics and biases and behavioural finance have not always been accepted by investors and economists (Hirshleifer, 2001). Edward Mason described the behavioural theory of the firm as being inferior for purposes of economic analysis (1952), while Friedman (1953) criticised behavioural theories for focusing too much on 'realism' and not enough on accurately predicting behaviour. This has changed in recent years, however, as evidenced by the myriad books emphasising the psychological side of investing (for example, Nosfinger, 2005; Pompian, 2006; Shefrin, 2002).

In his 2001 survey of the literature, Hirshleifer looks at how heuristics and biases affect investors. Some common investor biases he discusses include the *gambler's fallacy* in which investors believe that a string of bad results make a good result more likely (Andreassen & Kraus, 1990), and the related *hot hand fallacy* (Ayton & Fischer, 2004), where investors believe that certain shares are "on fire" and start following trends. Hirshleifer also discusses *conservatism*, a bias where investors stubbornly hold on to their beliefs when confronted with contradicting evidence (Edwards, 1968). Conservatism has been associated with anchoring and adjustment (for example, LeBoeuf & Shafir, 2006), often to explain why participants adjust insufficiently. Other commonly discussed biases include *overconfidence* (Odean, 1998), *risk aversion* (e.g. Bekaert, Hodrick, & Marshall, 1997), and the *sunk-cost fallacy* (Arkes, & Blumer, 1985).

Very little research has been done on the anchoring bias and the stock market, with an article by Mussweiler and Schneller (2003) being the most prominent study in the field to date. The remainder of the literature review will provide an in-depth analysis of the anchoring

and adjustment bias and how it relates to stock market investors.

2.3 Anchoring and adjustment

The principle behind anchoring and adjustment was first investigated in a series of experiments by Slovic and Lichtenstein on preference reversals (Lichtenstein & Slovic, 1971; Slovic, 1967; Slovic & Lichtenstein, 1968). In their experiments, participants changed their preferences depending on how the bet was framed. For example, participants in one condition based their decisions almost entirely on how much money they stood to lose with the bet (Slovic & Lichtenstein, 1968). Participants anchored their decisions on the salient feature of the bet (the amount to lose) which then had a disproportionate effect on their final decisions. By highlighting different features of the bets, the researchers changed participants' anchors and as a result their preferences.

Although very important to the development of anchoring, these studies lacked in both a theoretical framework to describe the phenomenon they studied, and in scope, as all the studies were done on preference reversals and bets. It was not until the seminal work done by Tversky and Kahneman (1974) that anchoring and adjustment was formulated as a fundamental bias that could affect decisions in a wide array of situations. They demonstrated how the bias occurs in bets (similar to Slovic and Lichtenstein), but also in questions of general knowledge, subjective probability assessments, and absolute estimates. As such, their research set the groundwork for all subsequent studies on anchoring and adjustment.

Since Tversky and Kahneman's (1974) article on anchoring and adjustment the field has developed significantly. Researchers have studied anchoring effects in situations outside of the laboratory, including stock markets (Mussweiler & Schneller, 2003), real estate (Northcraft & Neale, 1989), auditing (Joyce & Biddle, 1981), courts (Englich & Mussweiler, 2001; Englich et al., 2006) and car shops (Mussweiler et al., 2000). It has further been used to influence consumer's purchase quantity decisions (Wansink et al., 1998) as well as willingness-to-pay and willingness-to-accept decisions (Ariely et al., 2003; Simonson & Drolet, 2004; Wu, Cheng, & Li, 2008). Research on university rankings (Bowman & Bastedo, 2010), negotiations (Galinsky, Ku, & Mussweiler, 2009; Ritov, 1996), and self-perception (Kruger, 1999) all found evidence of an anchoring effect. More than just showing the prevalence of anchoring effects, these studies all give valuable insight into the anchoring process and its characteristics.

The scope of anchoring research has led to different researchers interpreting the word *anchoring* differently. In broad terms, anchoring and adjustment refers to the assimilation of an uncertain judgement towards a salient anchor. However, the word anchoring is also used to refer to different aspects of anchoring and adjustment research (Chapman & Johnson,

2002). Many researchers use it to refer to an experimental procedure where an uninformative number is presented to participants as an anchor before an absolute estimate is made. This procedure was first used by Tversky and Kahneman (1974) and has since been used in most studies on anchoring. The typical anchoring procedure is often referred to as the *classic anchoring paradigm* (Wilson et al., 1996). Anchoring also refers to a phenomenon in which a salient but uninformative anchor leads to the assimilation of related judgement. Researchers often refer to this as the *anchoring effect* or the *anchoring bias*. Finally, anchoring can refer to the psychological process through which an anchor affects a judgement. When the process is referred to, it is common to refer to the specific process, such as *selective accessibility* (Strack & Mussweiler, 1997) or *serial-* or *insufficient adjustment* (Epley & Gilovich, 2001).

The following topic will begin by looking at how the anchoring process works. This will be followed by an examination of the different anchoring biases. The topic will conclude with a look at the characteristics and limitations of the anchoring bias.

2.3.1 The anchoring process

Heuristics and biases research typically identifies a systematic bias before proposing a mechanism to explain it. The proposed heuristic is based on the bias shown in a set of mapping experiments. For anchoring and adjustment, there were four experiments leading to the hypothesised anchoring process (Tversky & Kahneman, 1974). However, as research on anchoring continues, new experimental results cast doubt on the accepted mechanism (for example, Wilson et al., 1996) which leads to new processes being developed.

Understanding the exact nature of the heuristic process is crucial in research on biases. By understanding the process, limitations and boundary conditions can be identified. This, in turn, can lead to potential debiasing techniques (Chapman & Johnson, 2002). As such, the following section is crucial as it shapes our interpretation of all subsequent research. Three important stages in the development of the anchoring process will be investigated: Insufficient adjustment, selective accessibility, and different anchors—different processes. A final section will look at processes that do not fit into these sections.

2.3.1.1 Insufficient adjustment

Tversky and Kahneman (1974) described the anchoring process as follows:

In many situations, people make estimates by starting from an initial value that is adjusted to yield the final answer. The initial value, or starting point, may be suggested by the formulation of the problem, or it may be the result of a partial computation. In either case, adjustments are typically insufficient. (p. 1128)

This concise description contains all the important information by Tversky and Kahneman regarding the anchoring process. First, people anchor on a value. This value can either be externally provided to participants or it can be self-generated. Second, people adjust from this value towards the target judgement. Finally, adjustment tends to be insufficient.

In the first of four experiments by Tversky and Kahneman (1974), participants were given an anchor by spinning a wheel of fortune. Participants then had to guess if the percentage of African nations in the United Nations was higher or lower than their anchor. As hypothesised by the researchers, participants who received a high anchor gave higher estimates than participants who received a low anchor.

In the second experiment, participants in two groups were given too little time to calculate the answer to the same mathematical function ($8!$) expressed in two ways (Tversky & Kahneman, 1974). Participants in the high anchor condition received $8 \times 7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1$ while participants in the low anchor condition received $1 \times 2 \times 3 \times 4 \times 5 \times 6 \times 7 \times 8$. The researchers hypothesised that participants would calculate the first few steps of the function before using their intermediary answer as an anchor. The results confirmed this, with participants whose first few steps resulted in a higher anchor giving significantly higher estimates than participants whose first steps resulted in a lower answer. Furthermore, because the anchor was lower than the target, both groups provided answers significantly lower than the target.

The third experiment discussed by Tversky and Kahneman (1974) was based on an experiment conducted by Bar-Hillel (1973) and examined people's difficulty in estimating conjunctive and disjunctive probabilities. A conjunctive proposition is true only if all its propositions are true, while a disjunctive proposition is true when any one of its propositions is true. In the experiment, participants had to choose whether to bet on a conjunctive, disjunctive, or simple proposition. The conjunctive proposition had an overall probability of 0.48 and the probability of each event was 0.9. The disjunctive proposition had an overall probability of 0.52 and the probability of each event was 0.1. The simple event had a probability of 0.5. As participants were aware of the probability of each event but not the overall probability, the conjunctive single-event probability acted as the high anchor while the disjunctive probability acted as the low anchor. As expected, when researchers asked participants to bet on the events, participants most often bet on the conjunctive event and least often on the disjunctive event, even though the disjunctive event was the most probable and the conjunctive event the least. Because participants anchored on the probability of the initial propositions and then adjusted insufficiently for the number of times they needed to occur, they incorrectly estimated the overall probability and thus made biased decisions.

The fourth and final experiment showed how participants could be internally anchored (Tversky & Kahneman, 1974). Two groups of participants were used. The first group was asked to provide estimates that they were either 10% or 90% sure would be larger than the target quantity (for example, the air distance from Delhi to Peking). As people do not adjust enough from an anchor, the researchers expected participants' answers to be too close to the actual values. This was confirmed, as the mean quantity provided by the participants in the 10% subjective probability condition was larger than the target quantity 24% of the time. The second group of participants were provided with the median estimates from the first group and asked to estimate how likely it was that these estimates would be larger than the target quantities. As the first group gave values with a subjective probability of either 0.1 or 0.9, the second group should have given similar odds. Instead, the second group gave odds of 3:1 rather than 9:1. Tversky and Kahneman hypothesise that this occurred because participants used a 1:1 internal anchor which they then adjusted insufficiently to reach a final estimate. As such, neither group was explicitly provided with an anchor. Participants in the first group were anchored on a value they estimated, while participants in the second group were implicitly anchored on a 0.5 probability.

With these experiments, Tversky and Kahneman (1974) provided evidence for their proposed process of anchoring and adjustment. Participants all had an initial value (either self-generated or externally-provided) which served as an anchor. Judgements were influenced by these anchors and tended to be skewed towards the initial anchors, suggesting a process of adjustment. What the experiments by Tversky and Kahneman fail to address is why adjustment is insufficient (Lopes, 1982). Since 1974, multiple explanations for insufficient adjustment have been proffered, with most revolving around the conservation of cognitive effort or the uncertainty of the final answer (Chapman & Johnson, 2002).

Theories on the conservation of cognitive effort assume that obtaining an anchor is automatic while adjustment from the anchor is effortful (Chapman & Johnson, 2002). When participants are provided with an anchor, they automatically fixate on the anchor before adjusting it. However, as adjustment is effortful, participants attempt to conserve cognitive energy (because they are *cognitive misers*; Fiske & Taylor, 1984) by halting the adjustment prematurely.

The cognitive effort explanation of insufficient adjustment often made use of studies that focus on anchors being given too much weight (for example, Kruger, 1999), rather than on irrelevant anchors. According to these studies, the integration and weighting of anchors require more effort than is given by, or available to the judge. Research by Gilbert (e.g. Gilbert, Pelham, & Krull, 1988) on cognitive busyness is usually cited as supporting this explanation, but no study has explicitly tested the relationship between Gilbert's work on

cognitive busyness and insufficient adjustment (Chapman & Johnson, 2002).

There are three problems with the cognitive effort explanation of insufficient adjustment. First, incentives have little to no influence on the anchoring effect (Wilson et al., 1996). If lack of cognitive effort leads to insufficient adjustment, incentives should increase the cognitive effort and thus decrease the bias. Second, forewarnings and information regarding the anchoring effect fail to reduce the bias (George, Duffy, & Ahuja, 2000; Wilson et al., 1996). If a lack of effort leads to an anchoring effect, specifically informing participants of a way to decrease the bias should have decreased the bias. As this did not occur, it is unlikely that anchoring and adjustment is an effortful process. Third, experts are as affected as non-experts are by the anchoring effect (Englich et al., 2006). Since experts are better able to conserve cognitive effort (Chapman & Johnson, 2002), research comparing experts to lay-people should have displayed smaller anchoring effects. For these reasons, it is unlikely that the insufficient adjustment is caused by a lack of cognitive effort.

A second line of reasoning focuses on the uncertainty of the absolute judgment. The most popular hypothesis posits that adjustment is insufficient because participants adjust until they reach an answer that falls within an acceptable range of answers (Quattrone, Lawrence, Finkel, & Andrus, 1981). If participants adjust from an implausible anchor until a plausible answer is reached, high anchors would lead to higher judgements and low anchors to lower judgements.

What the uncertainty hypothesis fails to address is how anchoring occurs when the provided anchor is within the plausible range (for example, Northcraft & Neale, 1987). According to the uncertainty hypothesis, no adjustment should take place when the anchor is plausible. However, research has shown that anchoring effects occur with both plausible and implausible anchors. Furthermore, extreme anchors lead to more extreme anchoring effects (Chapman & Johnson, 1994), and the uncertainty hypothesis fails to explain this finding. According to the uncertainty hypothesis, as long as the range of plausible answers remains the same, the extremity of the anchor should not affect the estimate. While it is possible that extreme anchors could lead to uncertainty in participants (because they assume it is relevant; Grice, 1975) thus increasing their probability distribution for possible answers (Mussweiler & Strack, 2000b), no research has been conducted to support this theory. This explanation seems unlikely, however, as experiments are often overtly designed so as to make the anchor uninformative (such as using a wheel of fortune; Tversky & Kahneman, 1974). Furthermore, as mentioned earlier, participants who are forewarned about anchoring effects show no decrease in anchoring effects. Forewarned participants should be able to adjust beyond the first plausible answer, leading to smaller anchoring effects. The failure of the uncertainty hypothesis to address these concerns led to researchers proposing alternate

mechanisms to explain the anchoring effect.

2.3.1.2 Selective Accessibility Model

Because of the shortcomings of the insufficient adjustment model of anchoring and adjustment, researchers in the 1990s proposed alternate mechanisms to explain the anchoring bias. The most convincing of the proposed mechanisms were the theories focusing on semantic priming caused by anchors (see Chapman & Johnson, 1999; Kahneman & Knetsch, 1993; Mussweiler & Strack, 1997). Semantic priming occurs when thinking about one topic acts as a prime for semantically related topics, allowing them to be accessed more readily (Reisberg, 2007). Foremost among these theories is the model of selective accessibility proposed by Mussweiler and Strack in 1997.

In their research, Strack and Mussweiler (1997) investigated how anchoring occurs when plausible anchors are used. They hypothesised that if the anchoring bias occurs due to a priming effect rather than insufficient adjustment, it would explain how anchoring occurs for both plausible and implausible mechanisms. Semantic priming would also explain the resilience of anchoring. In Strack and Mussweiler's theory there are three strategies that participants use to answer questions in the classic anchoring paradigm: (1) Participants know or believe that they know the answer to the question and the anchor has no impact on the answer they provide; (2) participants disregard the anchor based on categorical knowledge (used when anchors are very implausible, Mussweiler & Strack, 2000a), for example "no river is longer than 20,000 km;" and (3) participants create a complex mental model (Johnson-Laird, 1983) in which a plausible anchor is tested as a possible answer.

When an anchor is implausible, participants use insufficient adjustment until a plausible anchor is reached (Strack & Mussweiler, 1997). Once participants have a plausible anchor, they make use of complex decisional models (which include hypothesis testing) to obtain a better estimate (Mussweiler & Strack, 2000b). Because hypothesis tests make use of a positive test strategy where confirmatory evidence is searched for (Klayman & Ha, 1987; Wason, 1960), testing the anchor increases the accessibility of anchor-consistent information leading to a knowledge base which is biased towards the anchor. When participants subsequently make absolute judgements they depend on easily accessible knowledge (Higgins, 1996; Wyer & Srull, 1989) which leads to answers being assimilated to the anchor.

Based on this hypothesis, the researchers argued that research done on priming effects should be applicable to the model of selective accessibility but not to the insufficient adjustment model (Strack & Mussweiler, 1997). To test this, the three characteristics of priming effects were tested: (1) Priming effects are only effective if the primed information is

applicable to the question; (2) priming effects can lead to contrast effects if the primed information is dissimilar enough from the target judgement; and (3), priming effects improve the response latency (the time between receiving the question and giving an answer) when answering primed questions.

To test the first characteristic of priming effects, Strack and Mussweiler (1997) conducted an experiment with two groups of participants. For the first group, the anchor was semantically applicable to the target judgement (height and height). For the second group, the anchor was not applicable to the target judgement (height and width). If insufficient adjustment was the mechanism of anchoring, the anchor would have had a similar effect on both of these questions. However, if selective accessibility took place, the information made accessible by the comparative question would only be applicable to the first question and not the second. As such, the anchoring effect would only occur in the first question and not in the second. As hypothesised, the answers were most biased when the comparative and absolute task had the same focus. When the focus of the question changed, the anchoring bias was either considerably weaker or non-existent. A similar result was obtained by Chapman and Johnson (1994). They found that anchoring effects only occurred when the anchor and target were compatible.

To examine the second characteristic of priming effects, Strack and Mussweiler (1997) tested whether anchors could produce contrast effects. Contrast effects occur when highly accessible content is used as a comparison standard for a contrasting judgement. This leads to answers being biased away from the prime (see Strack, Schwarz, & Gschneidinger, 1985). The researchers once again used two conditions, one in which the anchor was relevant to the target (Hawaii and Hawaii), and one in which the anchor contrasted with the target (Hawaii and Antarctica). If insufficient adjustment was used, the anchor would have the same effect regardless of the semantic content. However, if semantic priming was used, participants primed with the contrasting anchor would show contrast effects. The results confirmed the presence of the selective accessibility mechanism: when the anchor and target had the same focus a significant anchoring effect occurred but when the anchor contrasted with the target the answer was biased away from the anchor (Strack & Mussweiler, 1997).

The final experiment conducted by Strack and Mussweiler (1997) examined the latency of participants' responses to anchoring questions with plausible and implausible anchors. Research on semantic priming has shown that highly accessible information leads to lower response latencies on related questions (Neely, 1977, 1991). According to the semantic priming theory, the response latency for the absolute and comparative questions should be negatively correlated. The longer a participant considers whether an anchor is larger or

smaller than the target during the comparative question, the more relevant information is accessed for the absolute question. The researchers tested this hypothesis using multiple common anchoring questions with either plausible or implausible anchors. As plausible anchors can be contradicted using categorical knowledge (thus accessing very little applicable knowledge), they were expected to have a low response latency for the comparative question and a high response latency for absolute questions. In contrast, plausible anchors which require complex models were expected to have a high response latency for comparative questions and a low response latency for absolute questions. The results from the experiment supported this, with a strong negative correlation being found between the response latencies on comparative and absolute questions. All three experiments conducted by Strack and Mussweiler (1997) thus supported a semantic priming model of anchoring, rather than an insufficient adjustment model.

According to the selective accessibility model of anchoring there are two phases of anchoring (Mussweiler & Strack, 1999b). The first phase is the selection of an anchor. In the classic anchoring paradigm selection is simplified as participants are provided with an anchor by the researchers. However, the selection of an anchor may play an important role in everyday situations (Mussweiler et al., 2004). Anchors may be selected because conversational inferences suggest that they are relevant (Grice, 1975), because they are easily accessible, or because they are generated during an insufficient adjustment process (as with implausible anchors). In the second phase, participants compare the anchor to the target judgement, leading to the heightened accessibility of anchor-consistent information. To test if anchoring activates anchor-consistent information, Mussweiler and Strack (2000a) made use of a lexical decision task. Their results showed that participants who were provided with a high car price had lower latencies when identifying words associated with expensive cars (for example, BMW), than those provided with a low car price, and vice versa. This further supports the theory that anchors lead to the activation of anchor-consistent information.

This model has a few important implications. First, prompts to consider anchor-consistent information should have no effect on the anchoring bias (as that information is already activated), while prompts to consider anchor-inconsistent information should debias the effect (supported by Chandon & Wansink, 2007; Chapman & Johnson, 1999; Mussweiler et al., 2000). Second, since activation is an automatic process, random or irrelevant anchors will have as significant an effect as informative anchors (supported by Cervone & Peake, 1984; Chapman & Johnson, 1994, 1999; Mussweiler & Strack, 2000b; Russo & Shoemaker, 1989; Tversky & Kahneman, 1974). Third, any factor that allows more anchor-consistent information to be made accessible will lead to larger anchoring effects (Chapman &

Johnson, 1999). Chapman and Johnson (1999) tested these hypotheses and their results supported the presence of a semantic priming model of anchoring.

The model of selective accessibility also provides an explanation for the robustness of the anchoring bias found in earlier studies. When participants answer the absolute question using a biased information pool, providing forewarnings that participants should “adjust more” is unlikely to be effective (Wilson et al., 1996). In a study on decision support systems (George et al., 2000), participants who provided answers too close to the anchor were informed that their answers were biased and given an opportunity to change them. However, because participants’ judgements were supported by their available knowledge, participants were unaware of the direction and size of the bias. This led to participants in both the high and low anchor conditions adjusting their estimates downwards.

Similarly, because knowledge accessibility effects are primarily automatic processes, they are unaffected by effortful thought (Higgins, 1996). As such, incentives to engage in more effortful thought are unlikely to affect the anchoring bias. The only way in which effortful thinking could reduce the anchoring bias is if the content of the additional thinking was systematically different from the content accessed earlier (Epley & Gilovich, 2005). However, there is no reason to believe that this will be the case. In research on incentives, Arkes (1991) concluded that incentives had very little impact on assimilation effects.

Due to the strong weight of evidence in support of the selective accessibility model of anchoring it is the primary model used to explain the anchoring bias. Some research has, however, contested the pervasiveness of the selective accessibility model of anchoring. The following section will look at the work by Epley and Gilovich which argues that different anchors result in different processes.

2.3.1.3 Different anchors, different processes

In 2000, Mussweiler and Strack stated that “it seems unlikely that—given the diversity of paradigms—all assimilation effects that have been labelled anchoring effects are mediated by the same mechanism” (Mussweiler & Strack, 2000a, p. 1050). Shortly thereafter, Epley and Gilovich (2001) hypothesised that different anchors would lead to different psychological mechanisms.

When participants are given externally-provided anchors, they have to consider the possibility that the anchor itself could be the correct answer, no matter how fleetingly (Epley & Gilovich, 2001). This leads to the activation of anchor-consistent information and thus the selective accessibility process. By contrast, when participants generate the anchor themselves they never consider the possibility that the anchor is the correct answer. Instead, they engage in a process of continuous adjustment where they adjust from the anchor,

examine the adjusted value, and then adjust it more until they feel that it is accurate.

Epley and Gilovich (2001) tested this hypothesis in three experiments. In the first experiment, participants were asked to verbalise their thoughts while completing anchoring questions. Participants who were provided with anchors were significantly less likely to describe a process of continuous adjustment than participants who generated their own anchors. This provided preliminary support for the researchers' hypothesis.

The second and third experiments (Epley & Gilovich, 2001) used the same questions as the first experiment but asked participants to engage in behaviours designed to make them more likely to accept or reject their adjusted answers (for example, nodding their heads; Wells & Petty, 1980). The results showed that when participants nodded their heads they had a lower response time and a stronger bias, but only with self-generated anchors. When the anchor was experimenter-provided there was no significant difference in participants' response times or answers. These findings were repeated in another experiment by Epley and Gilovich (2004). This effect can be explained by insufficient adjustment but not by selective accessibility. As such, it supports Epley and Gilovich's hypothesis that different anchors lead to different processes.

In a follow-up study, Epley and Gilovich (2005) found that financial incentives affected self-generated anchors but not externally-provided anchors. This is in line with their hypothesis that different anchors lead to different processes, as motivation and effortful thinking should affect adjustment (which is an effortful process; Epley & Gilovich, 2001) but not selective accessibility (Chapman & Johnson, 2002). A second experiment from the same study tested the effects of forewarnings on self-generated and experimenter-provided anchors (Epley & Gilovich, 2005). As in previous studies, self-generated and experimenter-provided anchors responded differently to the manipulation, with only self-generated anchors being affected by the warnings. This, together with the research by Epley and Gilovich (2001), provides convincing evidence for different anchors effecting different processes.

As Mussweiler and Strack wrote in their article on the semantics of anchoring and adjustment:

With such a perspective on psychological processes rather than judgmental effects we may well find that what has previously been considered as instantiations of one judgmental heuristic called 'anchoring' is actually a conglomeration of fairly diverse phenomena whose similarity rests solely on the net outcome they produce. (Mussweiler & Strack, 2001, p. 253)

The research by Epley and Gilovich (2001, 2004, 2005) confirmed this. Research on anchoring and adjustment has continued to find situations in which mechanisms other than

selective accessibility and insufficient adjustment are used.

2.3.1.4 Other mechanisms

One of the earliest anchoring mechanisms proposed that participants base their answer on the anchor because it is mentioned by the researcher. According to Grice (1975), people assume that any contribution to a conversation is relevant and appropriate to the conversation at that stage. In anchoring experiments, participants assume that the information that researchers give is relevant to the question at hand leading to answers which are biased towards the anchor (Schwarz, 1994). An experiment by Chapman and Johnson (1999) showed that anchors which were perceived as more informative led to larger anchoring effects, which provides some support for a conversational account of anchoring. However, in all the studies conducted on uninformative anchors (including Chapman & Johnson, 1999) clearly uninformative anchors—such as the last two digits of participants' social security numbers or numbers obtained by spinning a wheel of fortune—still lead to a significant anchoring effect (for example, Chapman & Johnson, 1994; Mussweiler & Strack, 2000b).

A second suggested mechanism focuses on numerical priming. Kahneman and Knetsch (1993) suggested that anchoring could occur due to a “backward priming” mechanism where people consider any number in short-term memory as a possible answer. Wilson et al. (1996) expanded on this theory by suggesting that attention to a numerical anchor increases the accessibility of the number itself and of the numbers surrounding it. This leads to an increased probability of those numbers being selected in subsequent estimates. To test the numerical priming model (which they called *basic anchoring*; Wilson et al., 1996) the researchers conducted a series of experiments where the anchor was never consciously compared to the target. Instead, these experiments first entered the anchor into participants' short term memory (for example, by having participants write down pages of similar numbers as part of a handwriting experiment) before seeing if the anchor affected absolute judgements. Their experiments showed clear evidence of a basic anchoring effect. However, a basic anchoring effect was only present if participants paid sufficient attention to the anchor. In Wilson et al.'s experiment, only participants who performed computations on the number or who copied multiple pages of the number showed a basic anchoring effect. The need for sufficient attention was confirmed in an experiment by Wu et al. (2008).

Wong and Kwong (2000) added to the theory of basic anchoring by proposing that the numerical anchor is stored only as an absolute value while prefixes (such as the negative sign) and affixes (such as the unit of measurement) are stored separately. This led to the hypothesis that the absolute value of the number, not its real value, will serve as an anchor.

The researchers also argued that basic anchoring, rather than selective accessibility, is the primary anchoring process. These hypotheses were supported in a series of three experiments where semantically identical but numerically different anchors (such as 7300m and 7.3km) were given to participants. Their results showed that the numerically higher anchor (when prefixes and affixes are ignored) led to significantly higher estimates than the semantically identical anchor.

Wong and Kwong's (2000) experiments make three claims that contradict the selective accessibility model: (1) the absolute value rather than semantic value influences the subsequent numeric judgement; (2) the affix of the anchor (such as the unit) is often ignored in anchoring; and (3) one number can serve as both a high and low anchor depending on the unit the judgement is expressed in. However, Wong and Kwong's findings are yet to be repeated and most studies on numeric priming have found the results to be less convincing (for example, Brewer & Chapman, 2002; Mussweiler & Strack, 2001).

Brewer and Chapman (2002) found that random numbers do not consistently lead to basic anchoring effects. They also found that more extreme anchors did not lead to bigger anchoring effects, as the numerical priming account would expect. In another study, Englich (2008) found that participants who had target-relevant information were unaffected by basic anchoring but not by semantically related anchors. There is also research that suggests that basic anchors might still lead to a selective accessibility process. Specifically, an experiment on subliminal anchors (Mussweiler & Englich, 2005) found that subliminally presented anchors led to the activation of anchor-consistent information (measured by response speed in a lexical decision task). While there has been no further research on the topic, it does suggest that basic anchoring could be mediated by selective accessibility.

There is also significant evidence to contradict Wong and Kwong's (2000) assertion that numerical priming is the primary anchoring process. Research on the durability of anchoring has shown that anchoring effects in the standard anchoring paradigm could be present for more than one week (Mussweiler, 2001). This is conceivable with the selective accessibility model where information relevant to the question can remain activated and relatively unaffected for such a duration (Srull & Wyer, 1979), but cannot be explained by basic anchoring effects where the multitude of numbers encountered in everyday life will replace the numerical anchor. Further research by Mussweiler and Strack (2001) used Wong and Kwong's (2000) research method to test if basic anchoring effects can co-occur with selective accessibility. The researchers conclude that basic anchoring effects can occur, but only in situations where semantic influences are deliberately minimised. As such, it is likely that numerical priming is an exception rather than the rule, with most anchoring effects being explained by selective accessibility.

Another anchoring process, known as *physical anchoring*, was discovered by LeBoeuf and Shafir in 2006. In a series of creative experiments based on the classic anchoring paradigm, the researchers replaced the anchor and target judgement with physical measurements such as weights or lengths. In the first experiment, for example, participants were provided with either a long or short line which they were asked to extend or shorten until it was 3.5 inches long. As is typical in studies on anchoring and adjustment, participants who were provided with a long line (or high anchor) provided a longer estimate than participants who were provided with a short line. These findings were repeated in multiple experiments, including experiments on weight and volume. Although possible, it is unlikely that these effects are explained by semantic priming. Instead, the researchers suggest a “psychological tendency to adjust insufficiently in tasks that involve such estimation via adjustment” (p. 403).

Closely related to physical anchoring effects is research on *magnitude priming* (Oppenheimer, LeBoeuf & Brewer, 2008). Magnitude priming occurs when physical anchors cross-modally bias numerical judgements. This is to say that large or small anchors in one mode (for example, lengths) can lead to large or small judgements in another mode (such as numbers). In one experiment by Oppenheimer et al., participants who were instructed to draw short lines gave lower numerical answers to subsequent questions than participants instructed to draw long lines.

Magnitude priming, as with physical anchoring effects, is difficult to attribute to either selective accessibility or insufficient adjustment. It is impossible to adjust from the length of a line to the mean temperature in Germany, and similarly, the length of a line is unlikely to activate information on the mean temperature of Germany (Oppenheimer et al., 2008). Instead, it appears that these anchors prime general notions of largeness or smallness which in turn influence subsequent judgements.

2.3.2 Types of anchors

As the research by Epley and Gilovich (2001) shows, the type of anchor provided determines the anchoring mechanisms used, which has important implications for the anchoring effect. As such, readers should be aware of the anchor type when interpreting any research on anchoring and adjustment. The following section will look at the original categorisation of anchors into externally-provided anchors and self-generated anchors (Epley & Gilovich, 2001) before examining more recent research by Epley and Gilovich (2010) which expands the different anchor types to five. The section will conclude with a discussion on how anchor types will be used in the present study.

2.3.2.1 Externally-provided and self-generated anchors

The most common division of anchors separates self-generated anchors from externally-

provided anchors (Epley & Gilovich, 2001). These two anchor types have received considerable research and their effects are well documented. As the underlying processes for these anchor types are well understood, they present the most useful categorisation for research on anchoring and adjustment. Almost all research on anchoring and adjustment to date has, however, made use of externally-provided anchors. Only a few studies by Epley and Gilovich (2001, 2004, and 2005) have specifically examined the effect of self-generated anchors.

Externally-provided anchors are typically used in the two-stage experimental design pioneered by Tversky and Kahneman (1974). In the first stage, called the comparative question, participants are asked to compare the anchor to the target judgement. This is done by asking if the anchor is higher or lower than the target judgement. The aim of the comparative question is to make the anchor salient to the participant (Strack & Mussweiler, 1997). In the second stage, called the absolute question, participants are asked to estimate the target value.

Not all externally-provided anchors are provided using the two-stage design, however. In a one-stage design, the anchor is provided (typically as part of an information bundle) but there is no comparative question. As there is no comparative question, studies using a one-stage design rely on the anchor being a salient piece of information. Just as important as the anchor being salient, however, is that the anchor must be uninformative. Any effect that an uninformative anchor has on a judgement is necessarily a bias. In a study on real estate agents, the estate agents were provided with a full dossier on a house before being taken to see it (Northcraft & Neale, 1989). Included in the dossier was the house's listing price, a value which is uninformative according to normative theory but highly salient. Some participants were given a high listing price, others a low listing price, and the effects of these anchors on the absolute judgement were analysed. This is one of the first examples of a one-stage experimental design.

It is important to note that the mechanism leading to the anchoring bias in one-stage designs has not yet been studied. When the anchor is a salient comparison standard, such as the listing price of a house or the past price of a share (Northcraft & Neale, 1989; Mussweiler & Schneller, 2003), participants are likely to compare the anchor with the target judgement, resulting in the selective accessibility process. However, not all externally-provided anchors are salient comparison standards. For example, in an experiment on value estimates, Wu et al. (2008) provided participants with multiple numerically similar, but unrelated numbers (890 professionals worked on the product, it had been purchased by 900 clients, and it was going on sale in 850 sales offices worldwide) before asking them to estimate the value of a product. In this experiment, the anchoring process used is less clear. Mussweiler et al.

(2004) suggest that an anchor might be selected because it is easily accessible and comes to mind when the target is being evaluated. Numerical priming, caused by the repetition of the anchor, could lead to salient numbers which are not comparison standards being selected as anchors. These anchors would then lead to selective accessibility. An alternative explanation is offered by basic anchoring effects. The study by Wu et al. (2008) shares many similarities with research on basic anchoring effects, including a need for the anchor to be repeated multiple times for anchoring to occur. As such a pure numeric priming mechanism might also lead to the anchoring bias. This study shows the risk of assuming that all externally-provided anchors make use of the same mechanism.

According to Epley and Gilovich (2001), self-generated anchors differ from externally-provided anchors in that they are never considered as potential answers. As such, no activation takes place and selective accessibility cannot occur. Instead, participants serially adjust from the anchor until they find a plausible answer. To test this, the researchers evoked self-generated anchors by asking questions which had a salient, but incorrect, starting point (for example, "what is the freezing point of vodka?" which evokes an anchor of 0°C). Self-generated anchors are not only present in general knowledge questions, however. In a study on physical anchoring effects, participants were asked to draw a 3.5 inch line (LeBoeuf & Shafir, 2006). The researchers found that while the short anchor resulted in shorter lines than the long anchor, not providing participants with any anchor led to the shortest lines, which implies that participants anchored on a "zero-anchor." The short and long anchors were thus externally provided, but the zero-anchor was self-generated. Kahneman and Tversky (1974) also made use of a zero-anchor condition in their experiment on subjective probabilities. In this experiment, the researchers suggest that participants anchor on odds of 1:1 from which they adjust insufficiently. Yet another example of a self-generated anchor used by Tversky and Kahneman is found in their second experiment, where participants were asked to estimate the value of 8!. By completing some of the computations, participants generated an anchor which they knew was wrong.

When determining which anchoring process will be used, the most important characteristic of self-generated anchors is that they are incorrect beyond consideration (Epley & Gilovich, 2001). The moment participants need to test the hypothesis that the anchor might be correct, no matter how unlikely it is, anchor-consistent information is activated and the selective accessibility process biases the judgement. However, not all self-generated anchors are beyond consideration. For example, Epley and Gilovich (2001) asked participants to name the year in which George Washington was elected president. Participants were assumed to anchor on the year that the United States declared independence (1776) before adjusting upwards. However, in contexts where American history is not as well known, participants

might consider the year of independence as a viable alternative, leading to selective accessibility. Similarly, the incomplete computation and zero-line anchors mentioned earlier might be beyond consideration, but 1:1 odds on a confidence interval are certainly not. Similar to externally-provided anchors, self-generated anchors do not guarantee the occurrence of a specific anchoring process. Because of this, it is necessary to look at alternative methods of categorising anchors.

2.3.2.2 Five types of anchors

Epley and Gilovich (2010) examine potential ways in which anchoring and adjustment research can be broadened. One of the ways in which the researchers suggest that anchoring research can expand is by examining different anchor types. The researchers discuss five anchor types currently being researched:

- Intuitive approximations

- Best- and worst-case scenarios

- Incidental anchors

- Environmental suggestions

- Magnitude priming

Intuitive approximations, also called self-generated anchors in previous research (Epley & Gilovich, 2001), are approximations that individuals use before making a final decision. Individuals know that these approximations are incorrect so they are used as starting points from which serial adjustment occurs. Adjustment typically stops once individuals reach a plausible answer (Epley & Gilovich, 2004).

Best- and worst-case scenarios concern individuals' difficulties in evaluating probabilities. When participants anchor on a best-case scenario, the anchoring bias leads to estimations that underestimate delays or difficulties. When participants anchor and adjust from the worst possible outcome, their final expectations tend to be pessimistic (Rosenzweig, Epley and Gilovich, 2009 as cited in Epley and Gilovich, 2010). This area links up with Kahneman and Tversky's (1974) initial research on conjunctive and disjunctive probabilities.

Incidental anchors are anchors found in everyday life which are completely unrelated to the judgement to be made (Epley & Gilovich, 2010). For example, research has shown that the name of a restaurant ("Bistro 19" or "Bistro 97") can serve as an anchor that affects the price individuals are willing to pay for food (Crichton & Gilovich, 2008). Although the effects of such incidental anchors are small, they are not insignificant. Incidental anchors might be related to *basic anchoring* where mere exposure to a number is enough to bias estimates (Wilson et

al., 1996).

Environmental suggestion anchors are anchors which participants believe to be meaningful or informative. A house's listing price (as used in Northcraft & Neale, 1989) can, for example, be an environmental suggestion, because people believe the listing value to hold a clue to the house's worth. The sentence proposed by a lawyer in a criminal case (as examined by Englich & Mussweiler, 2001) is another example of an environmental suggestion.

The final anchor type, *magnitude priming*, is found when participants are anchored on small or large magnitudes. This anchor significantly affects participants' judgements in unrelated matters of magnitude. For example, in a study by Oppenheimer et al. (2008), participants were asked to draw lines of differing lengths before judging the mean temperature in July in Honolulu. The length of the line was shown to act as an anchor of magnitude for the subsequent absolute judgements.

While the five categories proposed by Epley and Gilovich (2010) are more up to date and precise than the original categorisation (Epley & Gilovich, 2001), the processes at work in these categories have not yet been tested or researched. As such, it is difficult to predict how these anchors would affect judgements in situations of uncertainty.

As none of the taxonomies are able to categorise the anchor according to the resultant anchoring process, it becomes crucial to understand the conditions which lead to the different anchoring mechanisms. Unfortunately, research on the processes is itself filled with contradictions and uncertainty. With these shortcomings in mind, the present paper will refer to anchors based on the process they are expected to evoke. In the literature review, when no process is mentioned, the selective accessibility model will be assumed as current research suggests it is the most commonly used mechanism.

2.3.3 Characteristics of anchoring

With the anchoring processes and anchor types understood, it is possible to look at the characteristics of anchoring. Perhaps the most studied attribute of anchoring is its robustness. Uninformative anchors (Tversky & Kahneman, 1974), extreme anchors (Chapman & Johnson, 1994), awareness of the anchoring bias (George et al., 2000), motivation to provide accurate answers (Wilson et al., 1996), expertise and familiarity (Englich & Mussweiler, 2001; Wright & Anderson, 1980), and information-rich settings (Mussweiler & Schneller, 2003) have all failed to diminish the anchoring bias. As such, the robustness of anchors will be the first characteristic discussed. Following the section on robustness will be a discussion on the durability of anchoring. The final characteristic examined will be the malleability of anchoring.

2.3.3.1 Robustness

Epley and Gilovich (2010) describe the first wave of anchoring research as focusing on the anchoring phenomenon and its limitations. However, most research on the limitations of anchoring and adjustment found it to be remarkably robust, rebuffing any attempts at manipulation. Research on the robustness of anchoring can be divided into six categories: Uninformative anchors, extreme anchors, forewarnings, motivation, expertise, and the availability of information. These will be looked at separately.

Uninformative anchors

Uninformative anchors have formed part of anchoring research since its beginning. In the first study on anchoring, Tversky and Kahneman (1974) provided participants with an anchor chosen by spinning a wheel of fortune. This was done to highlight that the anchor was random and not informative in any way. Since this study, most researchers have attempted to emphasise the uninformativeness of their anchors in some way. This stops participants from inferring that the anchor is relevant (Grice, 1975), and also makes any effect of the anchor nonnormative.

Researchers have used many different techniques to make anchors uninformative. Russo and Shoemaker (1989) used participants' telephone numbers as anchors, while Chapman and Johnson (1999), Simonson and Drolet (2004), and Ariely et al. (2003), used participants' social security numbers. Mussweiler and Strack (2000b) and Englich et al. (2006) had participants roll a die to determine the anchor. All these studies obtained significant anchoring effects.

A further way of making the anchor uninformative is to choose an anchor that is uninformative according to prevailing theories and norms. Mussweiler and Schneller (2003) made use of this strategy by having stock market investors anchor on past share prices. According to the efficient markets hypothesis, past price changes have no influence on future price changes and should be ignored (Fama, 1970). Northcraft and Neale (1987) made use of a similar uninformative anchor by having participants anchor on a property's listing price. According to normative theory, what the seller is asking for real estate should have no effect on the value and thus the appraisal of the property. Yet both the study by Northcraft and Neale and the study by Mussweiler and Schneller found a significant interaction between the anchor and the absolute estimate, even with participants who declared that the anchor was irrelevant to their judgement.

When an informative anchor is used, researchers occasionally undermine the source of the anchor to make it less informative. In a study by Englich and Mussweiler (2001) conducted on judges, the researchers informed the judges that the prosecutor's demand (which served

as the anchor) was made by a first-year computer-science student. The anchor, which could normally be seen as informative, was thus turned into an uninformative anchor by undermining the validity of the source. As in all previous studies, the anchoring bias was unaffected by the informativeness of the anchor.

Extreme anchors

A second approach used to test the limits of anchoring is to make use of extreme anchors. There are two reasons for this: First, extreme anchors are typically implausible which researchers assumed would make them less likely to be used. Second, extreme anchors were expected to have a proportionately smaller impact on the anchoring effect.

In line with research on uninformative anchors it was found that extreme anchors led to an anchoring effect (Chapman & Johnson, 1994; Quattrone et al., 1981). In a study by Chapman and Johnson (1994) the researchers used the price of lottery tickets as an anchor. The anchor was either higher than the lottery's maximum prize or lower than the lottery's minimum prize, making it extremely unrealistic. The researchers found that the extreme anchors still resulted in a significant anchoring effect

Of greater import to this study is the size of the anchoring effect. Research by Quattrone et al. (1981) found that extreme anchors do not lead to a proportionately extreme bias. The researchers asked participants if the number of Beatles albums that reached the top 10 were more or less than 100,025 before eliciting an absolute judgement. As expected, the anchoring effect was not proportionate to the size of the anchor. This finding was supported by Chapman and Johnson (1994). This is not, however, to say that extreme anchors have no effect. In the study by Chapman and Johnson, extremely high anchors resulted in the same estimates as high anchors, but extremely low anchors resulted in significantly smaller answers than non-extreme low anchors. Chapman and Bornstein (1996) found that both high and low extreme anchors led to a more significant bias, a finding which was repeated by Mussweiler and Strack (1999b).

A combination of the serial adjustment and semantic priming models provides the best explanation for these results. In situations with extreme anchors, categorical knowledge is used to make the comparative judgement leading to the activation of very little information (Strack & Mussweiler, 1997). Instead, participants serially adjust from the extreme anchor until an anchor is reached which cannot be disqualified using categorical knowledge. Participants then compare the more plausible anchor with the target assessment, resulting in selective accessibility. The explanation suggests that extreme anchors might lead to a larger (but not proportionately larger) bias. Since participants serially adjust from the extreme anchors until a plausible anchor is reached, there will be little to no difference between

different extreme anchors. However, there will be a difference between the extreme anchor and a plausible anchor, since participants with the extreme anchor will continue adjusting until they reach the edge of the distribution of plausible answers. Using this anchor (which should be further from the target judgement than any other plausible anchor) they engage in hypothesis testing.

In research on basic anchoring, Brewer and Chapman (2002) found that more extreme basic anchors did not lead to larger anchoring effects. This finding is difficult to explain using a pure numeric priming account, as an extreme anchor will not prime the same numbers as a plausible anchor.

Forewarnings

As neither uninformative nor extreme anchors decreased the anchoring bias, researchers tested the effects of forewarnings on the anchoring effect. As researchers believed that anchoring was caused by insufficient adjustment, they assumed that warning participants would lead to a purposeful increase in the adjustment and thus a decrease in the anchoring effect. However, since most anchoring effects are caused by the selective accessibility process, forewarnings had little effect.

The first study on the topic was by Quattrone et al. (1981) which showed that forewarnings had little or no impact on subsequent judgements. In a later study, Wilson et al. (1996) tested the effect of different warnings at different times during the classic anchoring paradigm. The researchers found no evidence that forewarnings significantly diminished the anchoring effect. The most powerful forewarning effect was found in the *after-initial estimate condition* where participants first gave an estimate before being warned of the anchoring effect and, importantly, its direction. Afterwards, participants were given an opportunity to provide a new answer. However, even after the warnings participants still showed a highly significant anchoring effect. Furthermore, as participants were explicitly informed of the direction of the bias, their subsequent adjustment can best be explained as a demand effect (Wilson et al., 1996).

Wilson et al.'s (1996) results were repeated in a study on decision support systems (George et al., 2000). Participants who gave an estimate too close to the anchor were provided with a warning. The results showed that although participants adjusted away from the anchor after the warning, the adjustment was not statistically significant. Furthermore, because anchoring occurs unintentionally and outside of conscious awareness, it was difficult for participants to know how much to adjust (George et al., 2000). This problem was exacerbated by the anchor being unclear (it was embedded in a dossier filled with potential anchors) as participants were unaware of both the size and the direction of the adjustment required.

Before concluding that forewarnings are generally ineffective at reducing the anchoring bias it is important to note that they are effective in certain situations. Specifically, forewarnings have effectively reduced the bias when participants made use of self-generated anchors rather than externally-provided anchors (Epley & Gilovich, 2005). Because self-generated anchors are consciously adjusted, warning participants that this adjustment will be insufficient results in participants adjusting the anchor more before reaching an estimate.

Motivation

The idea that motivation might influence the anchoring bias stems directly from the insufficient adjustment theory. According to this theory, participants conserve cognitive energy by adjusting only until a plausible answer is reached (Quattrone et al., 1981). As such, motivating participants to provide more accurate answers should motivate participants to expend more cognitive energy and thus adjust more. Another theory proposed that participants who are low on motivation are more likely to see the anchor as a hint of an expected answer (Schwarz, 1994).

An experiment by Ariely et al. (2003) had participants make purchase offers for certain consumer products. Participants showed a significant anchoring effect using irrelevant anchors (participants' social security numbers) even though participants knew they would be held accountable for their offers. As the objects were fairly expensive (\$70 average), it is safe to assume that participants were motivated to provide accurate answers. Wilson et al. (1996) also tested the effects of motivation on anchoring and adjustment. Before the experiment started, participants were told that the person who gave the most accurate answer to a specific question would win a prize. Participants in the incentive condition were told that the relevant question was the anchoring question, while participants in the no-incentive condition were told the relevant question was an unrelated question. Participants in the incentive condition reported being less influenced by the anchor. However, the results showed that motivation did not lead to a diminished anchoring bias. Tversky and Kahneman (1974), and Chapman and Johnson (2002) report similar findings.

In contrast with these results, Wright and Anderson (1989) found incentives to have a marginally significant effect on anchoring and adjustment. Their questions differed from Wilson et al.'s (1996) in that they asked for judgements of event probabilities. Given this difference, it is possible that different questions are differently affected by motivation. For example, the questions asked by Wright and Anderson lend themselves more to systematic calculation. One question asked participants to estimate the probability that a randomly chosen *Fortune 1000* CEO earns more than \$300,000 a year. Unmotivated participants might rely on intuitive estimates to provide an answer, while motivated participants could

start by reasoning that the top 250 CEO's certainly earn more than \$300,000 a year, which means that, at the very least, there is a minimum probability of 0.25. Both systematic reasoning and intuitive assumptions are affected by anchoring, but they may have different probability distributions for certain answers. According to Mussweiler and Strack (2000b), an estimate's probability distribution depends on the knowledge of a participant, and, as such, additional computations should lead to a tighter probability distribution and thus a smaller bias.

Epley and Gilovich (2005) found that motivation only affected responses on questions with self-generated anchors but not questions with externally-provided anchors. This is in-line with research showing that self-generated anchors are less robust than experimenter-provided anchors (Epley & Gilovich, 2001).

Expertise

Perhaps one of the most significant characteristics of anchoring and adjustment is that it is unaffected by expertise. Because experts make greater use of specialised heuristics and are typically more knowledgeable, researchers predicted that experts would be resistant to anchoring effects (Chapman & Johnson, 2002). However, multiple studies have since rebuffed this assumption. Research on auditors (Joyce & Biddle, 1981), realtors (Northcraft & Neale, 1989), school teachers (Caverni & Pris, 1990) automobile mechanics (Mussweiler et al., 2000), investors (Mussweiler & Schneller, 2003), and judges (Englich & Mussweiler, 2001; Englich et al., 2006) have shown that experts in all fields of expertise are affected by the anchoring bias. In Englich et al. (2006), the researchers found no significant difference between the answers of experts and non-experts, except that experts felt more confident in their judgements. They conclude that experts mistakenly think that they are less susceptible to the anchoring effect.

Mussweiler and Strack (2000b) argue that *general expertise* has no effect on the anchoring bias while specific knowledge does. This is to say that experts can use their field-specific knowledge to decrease the range of answers, but within this range experts are as affected as non-experts. This explains why Wilson et al. (1996) found no bias in participants high on expertise, as the researchers confounded general expertise and knowledge of the answers. The effects of knowledge on the anchoring effect will be discussed in greater detail in a later section.

Availability of information

A final way in which the robustness of the anchoring effect has been tested is by making use of an information-rich setting. With more information presented to participants, researchers hypothesised that participants would depend less on the anchor and more on the relevant

information.

Northcraft and Neale's (1987) research on estate agents was one of the first studies to make use of an information-rich setting. Participants were presented with information on the real estate sales for an entire city and the neighbourhood in which the property was situated, information about the property such as its size and condition, information on other properties in the neighbourhood, information on properties that failed to sell and information on other properties in the neighbourhood that were for sale. Participants were also taken to view the property in person. Even with all this information, the researchers found a significant anchoring effect for both amateurs and experts.

Chapman and Johnson (1999) experimentally tested the effect of information-rich settings on the anchoring effect. Participants were manipulated to have more or less information available on a given topic. The researchers surprisingly found that participants with more information available displayed a greater, rather than smaller, anchoring effect. This finding is explained by hypothesis-consistent testing (Mussweiler & Strack, 1999b). Because people search for evidence confirming, rather than contradicting, their hypotheses (Klayman & Ha, 1987, Sanbonmatsu, Posavac, Kardes, & Mantel, 1998), information-rich settings may lead to a larger bias as they include more anchor-consistent evidence for people to draw from. A similar finding was obtained in a study on the effects of mood on the anchoring bias (Englich & Soder, 2009). The researchers found that participants who engaged in more elaborate thinking showed a larger rather than smaller bias.

Taken together, the robustness of anchoring presents a considerable threat to stock market investors. It implies that investors would, for example, anchor on the prediction of a future growth made by a firm's publicist, regardless of the implausibility or extremity of the anchor. This anchor would be expected to influence amateur and expert investors alike, and the financial incentive for accurate assessments inherent in investing is unlikely to affect the anchoring bias. Furthermore, this anchor could have a significant impact even when there is a substantial amount of unbiased information available. In fact, the bias could be larger specifically because of the information-rich nature of investing. Perhaps the most problematic finding, however, is that warning investors about the anchoring effect is unlikely to reduce the bias.

2.3.3.2 Durability

Anchoring and adjustment is not only robust and impervious to external manipulations, it is also temporally robust, or durable (Mussweiler, 2001). This is to say that anchoring effects can persist over long periods of time with little to no change to the bias. This result is not surprising as experiments on priming have shown that knowledge accessibility effects can

last for up to a week (see Srull & Wyer, 1979, 1980). Tulving, Schacter, and Stark (1982), found that participants who were given a list of 96 words as primes had forgotten most of the words after a week, but still showed a significant priming effect. In contrast, Srull and Wyer (1980) found priming effects to become significantly weaker over time. The difference between these results could have to do with the frequency with which the primes are encountered in everyday life. Srull and Wyer primed participants with hostility towards a specific person rather than on words. Priming effects are only maintained if the primed individual has little interaction with the primed target before the effects are measured. If the individual frequently interacts with the target, new interactions serve as new priming events, undermining the effects of the experimental prime (Wyer & Srull, 1989). New primes only lessen the original priming effect if the interactions contradict the experimental prime. As such, it is unlikely to occur with primed words as any interactions with the primed word should reinforce the prime.

Mussweiler (2001) tested the durability of anchoring effects and compared it with the durability of other knowledge accessibility effects. Importantly, the researcher hypothesised that anchoring effects would be more durable than other knowledge accessibility effects because of the different way in which knowledge is activated by anchoring and adjustment. In priming studies, the activated knowledge is externally provided (such as the word list used by Tulving et al., 1982) while in anchoring studies, participants activate the knowledge on their own. This distinction is significant as priming loses its effect once individuals become aware of the external influence (Strack, Schwarz, Bless, Kübler, & Wänke, 1993). It has also been shown that self-generated beliefs are less affected by discrediting evidence (Davies, 1997). The result is that anchoring effects should be considerably more robust than typical priming effects (Mussweiler & Strack, 1999b).

To test whether anchoring effects are more durable than priming effects, Mussweiler (2001) made use of three experiments. In the first experiment, the researcher tested the durability of anchoring effects related to a fictitious target. Two conditions were used: In the first, there was no pause between the comparative and absolute questions. In the second, the researchers asked participants the absolute question a week after the comparative question. The researchers found a significant anchoring effect in both the no-delay and one-week delay conditions and there was no significant difference between the two conditions.

In the second experiment, Mussweiler (2001) obtained the same result for non-fictitious targets with which people rarely interacted. The third and most ecologically valid experiment tested the durability of anchoring effects for subjects people commonly encounter. As mentioned earlier, priming effects typically collapse when participants interact with the primed targets (Srull & Wyer, 1980). However, as in both the previous experiments,

Mussweiler observed a highly significant anchoring effect in both the time-delay conditions, and no significant difference between them. This finding highlights the remarkable durability of the anchoring effect as participants were likely to encounter a significant amount of information relevant to the target during the week, all of which could have counteracted the activated information.

This characteristic has important implications for investors. In many investment situations there is a time window between encountering an anchor and acting on it. However, because of the durability of anchors, investors who encounter anchors could be biased for significant periods of time. The durability of anchoring also undermines the ability to debias investors. Most debiasing techniques require an awareness of the anchor, and while this is possible in laboratory settings, it will not be possible for an investor to debias every anchor encountered in the weeks before a purchase decision is made.

It is important to note that not all anchoring effects are as durable as those studied by Mussweiler (2001). Basic anchoring effects, for example, have been shown to be fragile (Brewer & Chapman, 2002), with Mussweiler and Strack (2001) describing them as “transitive and short-lived” (p. 241). In this aspect, basic anchoring effects are more similar to pure priming effects than selective accessibility anchoring.

2.3.3.3 Malleability

The original description of anchoring as a number from which individuals serially adjust affected future research in more ways than just determining the process: It shaped the idea of the anchor as a static concept—a pure numeric representation devoid of meaning. As such, minor changes made in the presentation of the anchor were expected to have little effect on anchoring and adjustment. Once anchoring was reconceptualised as a selective accessibility effect this was no longer true. Changes to the way in which target-knowledge is searched for should affect the implications of the knowledge activated, and thus the subsequent anchoring effect (Mussweiler, 2002). This is to say that changes in the hypothesis that is tested (or the way in which it is tested) would lead to changes in the anchoring effect.

This hypothesis was tested by Mussweiler (2002). Mussweiler either primed participants to look for differences or similarities before presenting them with typical anchoring questions. He hypothesised that participants primed to search for differences would be less affected by anchoring than participants primed to search for similarities. The results supported this, with a significantly weaker anchoring effect obtained in the group primed to search for differences. In another study by Mussweiler (Mussweiler & Strack, 1999b), the researchers made use of subtle changes in the wording of questions to change the hypothesis that was

tested. Specifically, the comparative question asked half the participants if the anchor was larger than the target and the other half if the anchor was smaller. The researchers argued that the different comparative questions would lead to participants testing different hypotheses. The results confirmed this, with participants giving higher estimates for the “larger” questions and lower estimates for the “smaller” questions. The difference in the direction of search thus led to the same anchors resulting in different estimates.

The malleability of anchors could have important implications for investors. One of the most successful ways to debias anchors is the *consider-the-opposite* technique (Mussweiler et al., 2000) where people are encouraged to think of reasons why the anchor might be too high or low. Anchoring effects’ malleability implies that people might automatically search for contradictory evidence with certain conversational anchors, for example “Do you think 40000c is too expensive for SASOL?” However, a more reliable way to debias investors might be to change the way in which hypothesis tests are conducted, as was shown by Mussweiler (Mussweiler, 2002). Teaching investors to search for differences rather than similarities might achieve a more sustainable result.

A more pessimistic interpretation of the malleability of anchors is that it could lead to investors following price trends. When a share price shows a strong trend, it could change the focus of investors’ hypothesis tests from whether the current price is accurate to whether the trend will continue, leading to a more pronounced anchoring effect.

2.3.4 The limits of anchoring

As the previous sections showed, anchoring and adjustment is a robust, durable, and prevalent bias which influences a wide array of decisions. However, not all studies on the limitations of anchoring have failed to find limitations. Researchers have identified a number of factors which diminish the anchoring bias. Some factors, like attention to the anchor, anchor-target compatibility, and uncertainty, are conditions which need to be met for the anchoring bias to occur, while other factors, like emotions, persuasiveness and the number of anchors, influence the magnitude of the anchoring bias. The following section will look at these factors.

2.3.4.1 Attention to the anchor

One of the core conditions of anchoring and adjustment is that individuals must pay attention to the anchor (Chapman & Johnson, 2002). Experiments in the classic anchoring paradigm ensure this by including a question where participants actively compare the anchor with the target judgement. This question not only ensures that participants pay attention to the anchor, it also ensures that participants link the anchor to the target judgement. However, including a comparative question is not a requirement. One-stage designs, such as those

used by Northcraft and Neale (1987), make use of anchors which are included in the text. For one-stage anchors to be effective, it is crucial that the anchor is a salient value. One-stage anchors should also be logical comparison standards, such as a past share price compared with a future share price (Mussweiler & Schneller, 2003), or the market capitalisation of a company compared with its fundamental value (Marsat & Williams, 2009). Because judgement is fundamentally comparative (Eiser, 1990) participants automatically compare the anchor value to the target judgement without being asked to.

Another form of anchoring that does not use a comparative question is basic anchoring. Because basic anchors are not comparison standards, these experiments focus on making the anchor as salient as possible through repetition. Wilson et al. (1996) obtained basic anchoring effects by having participants copy five pages of similar numbers. In another experiment, Wilson et al. obtained a basic anchoring effect by manipulating the depth at which the anchor was processed. The more participants had to process a number, the stronger the anchoring effect.

From these studies it could be concluded that an anchoring effect is only found if participants pay attention to the anchor. However, as with most research on anchoring, there are studies that contradict this rule. Critcher and Gilovich (2008) found a small but statistically significant anchoring effect for anchors that were not processed, were not compared to the target judgement, and were not a salient comparison standard. For example, the number on a linebacker's jersey (94 or 54) influenced participants' estimates of his probability of sacking the quarterback. Similarly, Mussweiler and Englich (2005) and Reitsma-van Rooijen and Daamen (2006) both found that subliminally presented anchors could produce an anchoring effect. However, these anchoring effects (including those by Critcher and Gilovich) were very weak and short-lived.

That participants must pay attention to the anchor is the single biggest limitation of the anchoring effect. Investors come across hundreds of numbers in a typical day, but only those numbers which they pay attention to and are comparison standards for the target judgements are likely to serve as an anchor. Furthermore, anchors only result in biased judgements if they are uninformative or overweighted, which excludes many informative data sources in an investment context.

2.3.4.2 Anchor-target compatibility

Tversky, Sattath, and Slovic (1988) identified three forms of compatibility in priming: scale compatibility, strategy compatibility, and semantic compatibility. Semantic compatibility occurs when the prime and target are meaningfully related in some way. According to the selective accessibility model of anchoring, as long as the anchor elicits information

semantically compatible with the absolute judgement, it should lead to an anchoring effect (Strack & Mussweiler, 1997). Other research has suggested that anchors need to be on the same response scale as the target judgement (Chapman & Johnson, 1994). Meanwhile, research on basic anchoring effects has shown that neither semantic nor scale compatibility is a necessity (Wilson et al., 1996).

Chapman and Johnson (1994) first tested the importance of scale compatibility. The researchers found a significant anchoring effect only when the anchor was on the same scale as the target judgement. Kahneman and Knetsch (1993) obtained a similar finding. However, the conclusions that scale compatibility is required have been undermined by the use of anchors and targets which were also semantically incompatible. As such, the experiments generally show that the anchor and target need to be compatible, but they fail to specify the type of compatibility that is important.

The importance of semantic compatibility was first shown by Strack and Mussweiler (1997) in their study on the height and width of the Brandenburg Gate, and their findings were repeated in the same year (Mussweiler, Förster, & Strack, 1997). These findings make sense from a priming perspective, as compatibility between the activated knowledge and the target judgement is crucial for priming effects to occur (Higgins, Rholes, & Jones, 1977). Selective accessibility further suggests that scale compatibility is not important for anchoring effects (Strack & Mussweiler, 1997) as long as the anchor activates information that is meaningfully related to the target judgement.

In contrast with the assumptions of selective accessibility, Carroll, Petrusic, and Leth-Steensen (2009) found that semantic compatibility alone is not enough to obtain anchoring effects. In a series of experiments, participants answered comparative questions and absolute questions on different scales. The researchers concluded that the information activated on one type of scale is not necessarily applicable to judgements made on another scale even if semantic compatibility is held constant. As such, both semantic and scale compatibility might be required for anchoring to occur. To further complexify the situation, Wilson et al. (1996) suggest that semantic compatibility is not a requirement for anchoring effects. Participants who answered a comparative question on the number of African countries in the UN before giving an estimate of the number of doctors in the phone book displayed a small but statistically significant anchoring effect.

These experiments present a complex picture of anchor-target compatibility. It is clear that anchor-target compatibility is important for anchoring and adjustment, but few studies agree on the kind of compatibility that is important. Furthermore, it is uncertain if anchor-target compatibility is a requirement of anchoring effects or if it just strengthens anchoring effects.

At the very least, the research agrees that the anchoring bias is considerably diminished, often to the point of statistical insignificance, by a lack of compatibility.

As with attention to the anchor, the anchor-target compatibility limitation greatly reduces the scope of the anchoring effect in an investment context. It implies that anchors should only have large effects on judgements with which they are compatible, both semantically and on scale. For example, the total value of a past transaction is unlikely to serve as an anchor for the future value of the share, as the two values are not semantically linked. At the same time, P/E ratio (the ratio of the price of a company's shares to the company's earnings per share), which is arguably semantically linked to the future value of a share, should not serve as an anchor for the share's future value as the scales are not compatible.

2.3.4.3 Knowledge and uncertainty

The role of knowledge and uncertainty in anchoring and adjustment has been touched upon in earlier sections. Uncertainty is a precondition for any anchoring effects to occur (Chapman & Johnson, 2002). As investment decisions necessarily require predictions they are inherently uncertain (Shiller, 1999).

In order to describe the effect of knowledge on anchoring, Mussweiler and Strack (2000b) conceptualise uncertain judgements as a probability distribution. The position of the distribution is determined by the content of an individual's knowledge. For example, an investor with only positive knowledge about SASOL might have a probability distribution for the future value of the share with an expected value of 40,000c while a person with only negative knowledge about SASOL might have a probability distribution with an expected value of 25,000c. Selective accessibility anchoring affects this position by activating positive or negative information about the target.

The dispersion of an answer's probability distribution is determined by the amount and quality of knowledge that an individual has (Mussweiler & Strack, 2000b). Individuals with very little investment knowledge could conceive of SASOL's share price varying from 10,000c to 50,000c in the next two months, while experienced investors might have a probability distribution ranging from 30,000c to 40,000c. The dispersion of an individual's probability distribution will also determine whether an anchor lies inside or outside of the probability distribution (Mussweiler & Strack, 2000b). As discussed in the section on selective accessibility, plausible and implausible anchors lead to different anchoring processes (Mussweiler & Strack, 1999a), making this an important distinction.

In line with these hypotheses, Mussweiler and Strack (2000b) found that participants with less knowledge showed a significantly larger anchoring bias (see also Jacowitz & Kahneman, 1995). The experiments also showed that the position of a participant's

probability distribution can be affected by the anchor. Participants who knew very little about the target relied more heavily on the anchor for information, even when the anchor was clearly random and under the participants' control. The researchers hypothesise that the anchor might make anchor-consistent categorisations more accessible leading to the reliance on anchors in situations of uncertainty.

In a study by English (2008), the effects of knowledge on plausible anchors were investigated more closely. English hypothesised that participants with a large knowledge base will have more potential anchors available for use. However, because these anchors are not explicitly linked to the target judgement, while the externally-provided anchor is linked, these individuals should exhibit anchoring effects of the same magnitude as participants with little available knowledge. In an experiment where participants were provided with different amounts of target-specific information, this was confirmed. More than just confirming that knowledge does not always lead to a smaller anchoring effect, English (2008) found that an increase in knowledge could lead to a larger anchoring effect. Based on the work by Chapman and Johnson (1999), it is believed that participants with significant general knowledge on a topic can find more anchor-consistent information in their knowledge. This leads to a stronger assimilation effect.

These findings are not reassuring for investors as investors are likely to be high on general knowledge and expertise but also high on uncertainty (Shiller, 1999). Generalised uncertainty, as is likely to pervade many investment scenarios, leads to an increased anchoring effect (Nelson, 2005). Mussweiler and Strack's (2000) research on estimates and probability distributions implies that investors will be less influenced by anchors in the investment context than amateurs, as investors should have a narrower probability distribution and thus fewer plausible answers, but research indicates that many investment decisions would be highly susceptible to anchoring. Within investment decisions, decisions particularly high on uncertainty (such as predictions of AltX share prices or returns) will be more prone to anchoring effects.

2.3.4.4 Multiple anchors

To date, few experiments have examined the impact of multiple anchors on anchoring and adjustment; instead most experiments make use of a single anchor. In the classic experimental paradigm, participants are presented with a question and one anchor before being asked for an estimate. As a result, participants have no choice but to rely on the anchor provided. These experiments are not, however, ecologically valid. In experiments where the anchoring bias is tested in real life situations, multiple anchors are often present (e.g. Mussweiler & Schneller, 2003; Northcraft & Neale, 1987). For example, Northcraft and

Neale (1987) provided real estate investors with ten pages of information on a property which included anchors such as the price of properties that recently sold in the area, the listing price of the property, and the listing price of other properties in the area. In most experiments with multiple anchors, only one anchor differs between the high and low anchor conditions (the property's listing price in Northcraft and Neale, 1987). These studies, while including multiple anchors, do not specifically test the effect of multiple anchors. As such, only three studies have specifically investigated how multiple anchors affect anchoring and adjustment.

Whyte and Sebenius (1997) hypothesise that multiple anchors can influence the anchoring effect in two ways: (1) By decreasing the likelihood that participants will rely on any one anchor for their decision; and (2) by diluting the influence of an unreliable anchor. This is to say that in situations with multiple anchors, where at least one anchor is considered a biasing influence, multiple anchors can improve decision making by making it less likely that participants will rely on informative anchors. Furthermore, even when participants anchor on the biasing anchor, as long as they also make use of other anchors the influence of the biasing anchor will be diminished. A third potential way in which multiple anchors could affect the anchoring bias is by forcing participants to test a hypothesis that contradicts another anchor. This would result in participants automatically considering-the-opposite, a technique which has been effective in debiasing anchoring and adjustment (Mussweiler et al., 2000).

In order to test the effect of multiple anchors, Whyte and Sebenius (1997) conducted two experiments. In the first experiment, MBA students were provided with significant information on a product's value and price in a negotiation before being provided with an unreliable anchor. The researchers found that, even with reasonable anchors available, the unreliable anchor still resulted in a significant anchoring effect. The second experiment repeated the first but used a sample of experienced managers instead of MBA students. As with the first experiment, a significant anchoring effect was found. It is important to note, however, that the manipulated anchor was presented immediately before participants were asked to make a judgement, similar to anchors in the classic anchoring paradigm, while the informative anchors were embedded in the text. As such, it is possible that the manipulated anchor was more salient than any embedded anchors. The researchers also did not test if the anchoring effect was diminished by the presence of multiple anchors, simply whether it occurred.

Support for Whyte and Sebenius's (1997) hypotheses can be found in an older study by Switzer and Snizek (1991). In their experiment, participants were asked to estimate the number of sentences they could unscramble and transfer from a scrambled document to the correct source document in a five minute session. All participants were provided with an anchor (a low or high goal of sentences to sort), but only some participants were provided

with a second anchor (information about other participants' performance) which was chosen to be inconsistent with the first anchor. As hypothesised by Whyte and Sebenius, the second anchor diminished the anchoring bias significantly. However, as with the research by Whyte and Sebenius, no measure of the informativeness of the anchors was included. As such, it is difficult to say whether the mitigating influence of the second anchor is as a result of participants anchoring on the second anchor or because participants consciously used information on other participants' performance to moderate their own estimates.

A final experiment on the impact of multiple anchors was conducted by Ariely et al. (2003). In their experiment, students participated in three trials in which they listened to an unpleasant noise for thirty seconds. After each trial, participants were anchored on a value for the experience before being asked to state the minimum payment they would accept in order to listen to the noise again. The anchor changed in between each trial. Participants in the increasing condition were anchored on 10c after the first trial, 50c after the second trial, and 90c after the third trial, while participants in the decreasing condition were anchored on 90c first before being anchored on 50c and then 10c. The researchers discovered that while subsequent anchors can diminish the anchoring effect, the initial anchor (10c in the increasing condition and 90c in the decreasing condition) had a significantly stronger effect than any subsequent anchors. Ariely et al. (2003) suggest that, since the experience is novel to participants, the first anchor assigns a basis value to the experience while all subsequent anchors adjust the value from this basis. The result is thus a form of conservatism where, once an opinion is formed, subsequently presented information is underweighted (Edwards, 1968).

Taken together, these studies do suggest that the exact effect of multiple anchors depends on the context in which the anchors are experienced. Research by Whyte and Sebenius (1997) found a recency effect, where the most recent anchor had the greatest impact, while participants in Ariely et al.'s (2003) experiment showed a primacy effect where the anchors presented first had the greatest influence. Switzer and Sniezek (1991) did not test the effect that the order of anchors had. Ariely et al. (2003) and Switzer and Sniezek (1991) found that multiple anchors diminish the anchoring bias, while Whyte and Sebenius did not test how the anchoring bias was affected. More research on the effect of multiple anchors is clearly needed, especially considering the relevance of such research to anchors in everyday life.

Even so, the research on multiple anchors is heartening for investors. While participants in all three studies showed an anchoring effect, the effect was significantly smaller when a second contradictory anchor was included. Furthermore, in all three studies the anchor was specifically made salient by the researchers. It is uncertain how a less prominent, uninformative anchor will influence the results when there are informative anchors available

to investors. As many informative anchors are present in the investment environment (such as the share price), it is possible that the anchoring effect from uninformative anchors will be significantly diminished.

2.3.4.5 Emotions

Happiness significantly impacts the way in which individuals process information. People who are happy tend to rely more strongly on heuristics and intuitive judgements than people in neutral affective states (see Forgas, 1995; Schwarz, 1998). Negative affect, on the other hand, leads to more careful and systematic processing of information (Edwards & Weary, 1993).

Recently, multiple studies have investigated the effect of mood on the anchoring bias. First of these is Bodenhausen, Gabriel, and Lineberger (2000), which investigated the interaction between sadness and the anchoring effect. Because happiness leads to a stronger reliance on heuristics, it typically leads to larger cognitive biases. However, because elaboration increases the accessibility of anchoring consistent information (Chapman & Johnson, 1999), happiness might lead to a decrease in anchoring effects while sadness might lead to an increase. This was tested by Bodenhausen et al. (2000). The results confirmed their hypothesis, with sad participants giving more anchor-consistent answers than participants in the neutral-mood condition. In a second experiment, the researchers found that questions with a positive affective tone showed larger anchoring effects than questions with a negative tone. Bodenhausen et al., hypothesise that this occurred because people elaborate more readily on positive than negative topics.

In another study, the interaction between mood, expertise and anchoring was investigated (Englich & Soder, 2009). Specifically, the researchers were interested to see if the results reported by Bodenhausen et al. (2000) occur with people high in expertise, as the decision making processes of experts are less likely to be affected by their moods (Schwarz & Clore, 2007). The researchers concluded that happiness only influences anchoring effects for non-experts—experts show a significant anchoring effect regardless of mood. Importantly, they found that non-experts were only influenced by anchors when they were sad. Non-experts who were happy showed no anchoring bias. The general robustness of anchoring in other studies makes this finding very surprising. Englich and Soder (2009) question whether the experimental environment might lead to increased anchoring effects due to the negative affect associated with experiments.

A third study on anchoring and emotions found that challenge stress leads to more serial adjustment than threat stress (Kassam, Koslov, & Mendes, 2009). This is to say that participants who experience threat stress showed larger anchoring effects. Because threat

stress leads to feelings of inadequacy, participants who experience threat stress are likely to stop adjustment earlier than participants who feel challenged by the situation. This results in a larger bias.

Researchers in a final study on anchoring and emotions examined the impact that the intensity of emotions has on the anchoring effect (Araña & León, 2008). The researchers propose that high emotional intensity leads to disorganised thinking patterns which make a rational cost-benefit analysis difficult (Eysenck, 1982; Lazarus, 1991) while low emotional intensity leads to insufficient attention and mental arousal (Kahneman, 1973). Both should thus lead to a large anchoring effect. The results supported this, with the relationship between anchoring and mood intensity found to be U-shaped. The strongest anchoring effects occurred at very high or very low levels of emotional intensity. When emotional intensity is moderate, researchers found the anchoring effect to be “not significantly different from zero at the 99% level” (p. 707). It is possible to conclude that, similar to English and Soder (2009), experimental conditions lead to an increase in emotional intensity resulting in the robust anchoring effect typically obtained.

Together, these findings highlight some limitations of anchoring studies. Perhaps the most relevant finding for investors, however, is that emotions do very little to affect the anchoring bias for individuals high in expertise (English & Soder, 2009). While the anchoring bias in everyday life might be less pronounced than expected, there is no evidence that this would be the case for investors. It further seems likely that investors experience states of emotional intensity quite often, especially when making decisions. Thus, while research on emotions and anchoring is heartening for most people, it brings little good news for investors.

2.3.4.6 Attitudes and persuasion

The final limitation of anchoring to be investigated concerns the assumption that changes in attitudes would lead to changes in behaviour. Most studies to date have examined how anchors affect participants' judgements. For example, Tversky and Kahneman (1974) observed that a randomly chosen anchor affected participants' judgements of the percentage of African countries in the United Nations. Researchers assume that such changes in judgement would lead to similar changes in behaviour. However, a meta-analysis by Wicker (1969) concluded that, in general, attitudes and behaviours were correlated less than 0.30. This discrepancy between attitudes and behaviours was highlighted in an anchoring study by Brewer, Chapman, Schwartz, and Bergus (2007), where significant changes in doctors' and patients' attitudes towards diseases had no effect on their predicted behaviours.

While these results are very positive for investors, it is important to note that many studies

have shown a strong correlation between anchoring and behaviours. For example, Tversky and Kahneman (1974) showed that participants who could choose between two bets chose often made disadvantageous bets because of anchoring. Wansink et al. (1998) showed that anchors could have a significant effect on purchase quantity decisions made outside of the laboratory, while Mussweiler and Schneller (2003) showed that anchoring can affect investors' decision behaviour. More research will need to be done to clarify interaction between anchoring, attitudes and behaviours (Epley & Gilovich, 2010).

To conclude, anchoring and adjustment has five general limitations: (1) attention must be paid to the anchor; (2) the anchor and target judgement must be compatible; (3) individuals must be uncertain of the final judgement; (4) happiness and moderate emotional intensity can make the anchoring effect disappear; and (5) changes in attitudes do not always result in changes in behaviour. However, the general investment environment and the expertise of investors nullify many of these limitations, which make investors specifically vulnerable to anchoring effects.

2.4 Investors

As shown by the previous sections, anchoring and adjustment is a complex heuristic and its application to everyday situations is necessarily fraught with uncertainty. The following section will attempt to apply the research on anchoring and adjustment to the investment environment. It will begin by looking at the characteristics of the investment environment. These characteristics will determine the way in which the anchoring bias interacts with investors. Following this will be an examination of research that has already been done on anchoring and adjustment in investing. Afterwards, articles related to financial decision making will briefly be looked at. The section will conclude with an analysis of anchors that are likely to affect investment decisions.

2.4.1 The investment context

Multiple characteristics of the investment environment affect anchoring and adjustment. As was highlighted in the sections on the characteristics and limitations of anchoring and adjustment, many of these characteristics make the investment environment particularly vulnerable to the anchoring bias. However, some of these characteristics also moderate the anchoring effect. The most significant of these characteristics are investor uncertainty, increased knowledge, quantitative decision-making and multiple anchors. As these characteristics were discussed throughout the previous sections, they will not be covered in detail; instead, the characteristics and their expected effects on the anchoring bias will be briefly discussed.

2.4.1.1 Investor uncertainty

According to Sloman (1995), uncertainty is defined as an outcome, which may or may not occur, having an unknown probability of occurring. For investors, this describes all available investments: Equity investments may or may not appreciate, fixed income investments are affected by changes in market rates, and even hedged investments are affected by changes in market conditions. As a result, all investment decisions are inherently uncertain.

Uncertainty is a precondition of all heuristic use (Tversky & Kahneman, 1974), a condition which is clearly met in investing. As uncertainty increases, the room for behavioural biases to influence judgements increase, while a decrease in uncertainty results in a smaller bias (Mussweiler & Strack, 2000b). For investors, this implies that, in general, certain investment decisions, such as foreign exchange investments, will be more vulnerable to the anchoring bias than others (for example, variable rate bonds).

2.4.1.2 Increased knowledge

In order to improve investment decision making, investors rely on a large quantity of data and quantitative techniques. In a study by Grivillers (2007), 359 valuation methods were used in 100 valuations by professional investors, resulting in an average of 3.59 methods per valuation. Each of these methods is based on information about the firm which investors and analysts process, and results in more information about the firm. As such, investment professionals are typically very well informed about the firms they analyse or in which they invest.

The effect of an increase in knowledge on the anchoring effect is two-fold. More knowledge makes it easier for investors to find information supporting the anchor and thus results in a larger anchoring effect (Chapman & Johnson, 1999). However, more knowledge also decreases the range of possible answers, thereby decreasing the anchoring effect (Mussweiler & Strack, 2000b). The exact effect is likely to depend on the content of the information. General information which is open to interpretation is likely to increase the anchoring effect while information pointing towards specific answers is more likely to decrease the anchoring effect. For example, general information on market conditions should increase the anchoring effect because participants anchored on a high anchor will focus on the conditions supporting a high value, while those anchored on a low anchor will focus on the opposite. In contrast, share valuations should diminish the anchoring effect as they limit the range of viable estimates.

2.4.1.3 Quantitative decision-making

As the research by Grivillers (2007) highlights, professional investors rely on multiple

valuation methods when making investment decisions. Most common of these is the discounted cash flow method (81%), followed by trading multiples (71%), share price (67%), and revalued net assets (37%). Other than share price, these techniques are quantitative valuations that require little subjective interpretation. This emphasis on quantitative decision making in the investment environment can decrease the uncertainty of investment decision-making, thus decreasing the use of heuristics. This is most evident in the field of algorithmic trading where decisions are purely based on data without human intervention. However, it also affects non-algorithmic trading. Investors who, for example, base their decisions on the discounted cash-flow model will be less affected by salient anchors such as the current share price.

The reliance on quantitative techniques does not however nullify the anchoring effect. Because investors typically rely on multiple valuation methods, investment decisions still require that the information provided by the quantitative valuations be integrated into a single valuation. By activating anchor consistent information, the anchor will still affect the way in which the information is integrated. However, even in such situations, the quantitative valuations will decrease uncertainty by providing reasonable limits to the share's value. As such, the use of quantitative methods should decrease the anchoring effect.

2.4.1.4 Multiple anchors

A final characteristic of the investment environment is that there are typically multiple anchors. Past share prices, the current share price, estimated future prices, share valuations, and share trends can all serve as an anchor for investors. As such, any investor who does more than a cursory investigation of a share is likely to encounter multiple, often contradictory, anchors.

While the presence of an anchor is needed for an anchoring, and multiple anchors might thus be expected to bias investment decisions, research has shown that multiple anchors can moderate the effect of any single anchor (Switzer & Sniezek, 1991). By making it less likely that investors will focus on any single biasing anchor and by forcing participants to consider information supporting a variety of positions, multiple anchors are likely to result in participants basing decisions on an unbiased pool of information. This is not to say that no anchoring effect will occur. As was shown by Northcraft and Neale (1987) and Whyte and Sebenius (1997), an uninformative anchor can still bias decisions even when informative anchors are available. However, it is likely that the bias will be weakened.

Taken together, these characteristics suggest that while investment decisions may be affected by the anchoring bias, the bias is likely to be mitigated by the use of quantitative techniques and the presence of multiple anchors.

2.4.2 Five investment studies

To date, only five studies have investigated the effects of anchoring and adjustment on stock market investors. The first study looked at portfolio diversification, and how investors assessed growth and risk (Anderson & Settle, 1996). The second investigated if investors would assimilate investments towards a salient past high or low on a stock chart in contrast to what is prescribed by the efficient market hypothesis (Mussweiler & Schneller, 2003). The third study compared how investment professionals and students made long-term stock return evaluations (Kaustia et al., 2008). The fourth examined whether investors anchor on the price while evaluating the fundamental value of a share (Marsat & Williams, 2009) while the final study made use of computational algorithms to show that anchoring could lead to speculative bubbles (Williams, 2010).

2.4.2.1 Analysis of: The Influence of Portfolio Characteristics and Investment Period on Investment Choice

In the first study actively linking investment with anchoring and adjustment, Anderson and Settle (1996) investigate how portfolio allocation decisions are affected by mental biases. In order to test the effects of different biases, the researchers conducted five experiments. In most of these experiments participants relied on a *mental accounts decision rule* (a cognitive bias) to allocate their funds between risky and risk-free investments. This is to say that participants chose a specific distribution (e.g. 50% risky, 50% risk-free) which they stuck with regardless of changes in the risk and return parameters. However, the researchers also found a significant anchoring effect in the first experiment.

In the first experiment participants were given the one year risk and return information for a risk-free and high risk investment and asked how much they would invest in each investment for a period of ten years (Anderson & Settle, 1996). Participants were also asked to provide their best estimates for the ten year performance of these investments. After participants' gave their answers the researchers provided them with the ten year risk and return information for the same investments (although participants were unaware that the investments were the same) and asked them the same question. According to the results, participants invested considerably less in the high risk investment when given the one year information. This occurred because participants anchored on the risk and reward for one year and failed to adjust sufficiently for the dispersion of risk and the cumulative returns over a ten year period (Anderson & Settle, 1996). This is consistent with research showing that people are poorly equipped to estimate cumulative growth (Hammond & Summers, 1965; Wagenaar & Sagaria, 1975).

Using the data from participants predictions of future performance, the researchers

examined how many participants had answers adjusted from the one-year risk and return values (Anderson & Settle, 1996). They found that 87% of participants adjusted their answers from the mean, and that the adjustments were insufficient—only one participant came within 100% of the actual ten year growth, with the second closest participant being 606% off of the actual growth.

There are however significant problems with this study. For one, Anderson and Settle (1996) do not provide any evidence that anchoring led to the assimilation effect. The researchers show that participants underestimate the share growth and dispersion of risk over time, but they fail to show that this is caused by anchoring and adjustment. Another problem is the reliance on a sample of psychology students. Most participants in the study used a mental accounts decision rule to make decisions, something which is unlikely to be used by sophisticated financial decision makers.

With these problems in mind, what Anderson and Settle (1996) do show is how anchoring and adjustment could affect investment decisions, both in terms of judgements (participants predicted the growth to be much lower than it was) and in terms of behaviours (participants invested more heavily in the same investment when they were given ten year predictions). As such, it provides important preliminary evidence for the effects of anchoring and adjustment in an investment context.

2.4.2.2 Analysis of: “What Goes Up Must Come Down”—How Charts Influence Decisions to Buy and Sell Stocks

The second study attempts to show that while share prices do not have a memory, investors do, and even experienced investors make use of stock charts when making buy or sell decisions (Mussweiler & Schneller, 2003). To do this, Mussweiler and Schneller use salient highs and lows on stock charts to show how participants’ assessments of value are assimilated towards past prices.

Mussweiler and Schneller (2003) hypothesise that investors who are presented with a chart containing a salient high or low actively search for and activate evidence supporting this high or low price. To investors, a clear high on a chart attunes them to positive information about the stock, while a clear low makes them more aware of negative information, in line with the selective accessibility theory of anchoring (Strack & Mussweiler, 1997). The results from the study strongly support Mussweiler and Schneller’s hypothesis.

Mussweiler and Schneller (2003) conducted five experiments to test the effects of salient past prices. In all five experiments, a sample of investors (usually business students from the University of Würzburg) were presented with relevant financial information on one or more stocks, as well as a 12 month chart for the stock, before being asked to value the shares in

some way. Participants manipulated the stock charts so that they showed the exact same recent results, apart from having either a very salient high or low in the past.

While all five experiments followed the same basic research method they differed in a few significant ways—most notably in how the dependent variable was measured. In the first experiment (Mussweiler & Schneller, 2003), investors were asked to provide their best estimate of the stock's price in twelve months. This experiment thus measured participants' judgement regarding a future price. In the second experiment, participants were informed that they owned 100 shares of each of the stocks, and asked how many they would sell. As such, this study used a behavioural measure of the shares' values. Participants in the third experiment were provided with 12,000DM and asked to decide on a quantity of shares to buy from a set of stocks. The fourth experiment was similar to the third except that participants only invested in one stock and were provided with a much richer description of the stock. The final experiment was similar to the fourth, but instead of using a sample of university students with investment experience, Mussweiler and Schneller (2003) used a sample of experienced investors. Participants were also asked to list the characteristics that influenced their investment decision in the fifth experiment. In line with the selective accessibility process, investors who were provided with a salient low in their stock chart purchased fewer shares, listed more negative characteristics and listed fewer positive characteristics (Mussweiler & Schneller, 2003). The opposite occurred for investors with a high anchor. It is important to note that these investors were presented with the exact same share analysis with only a stock chart differing. Using regression analysis, the researchers went further to show that, if the impact of selective accessibility is ignored, the chart has no significant correlation with investors' responses.

The results from the regression analysis can, however, be questioned. By asking participants to justify their investment decisions, the researchers did not record which information was accessible to participants but rather which information participants felt supported their investment decisions. Participants who invested very little in a stock were unlikely to have listed many positive characteristics of the stock to support their decision, while the opposite was true for participants who invested a lot. The sample used by Mussweiler and Schneller (2003) is also problematic. The sample consisted primarily of students who were part time investors, and it could be argued that the students were not representative of the average investor. Only the last experiment used a sample of experienced professional investors, but this sample was small. A third problem with the study by Mussweiler and Schneller concerns the anchor. While past stock prices are normatively uninformative (Fama, 1965), this does not preclude investors from actively using them when making decisions. As the researchers did not measure how informative

participants found the anchor it is impossible to judge whether participants found the anchor uninformative.

However, the most significant problem with Mussweiler and Schneller's (2003) research method concerns the research materials. In three of the five experiments conducted by Mussweiler and Schneller, participants were provided with insufficient information to make any investment decisions. As such, decisions necessarily had to be based on a general feeling regarding the firms. It is clear that an anchor could affect such a vague feeling, but it is unclear if investment decisions would be affected by it. In the final two experiments, participants were provided with a richer description of the stocks. However, there is no evidence given that the information provided allowed participants to calculate common quantitative valuations, such as free cash flow to firm (Grivillers, 2007). Furthermore, even if participants had the information needed, it is uncertain whether participants would have sufficient time and be sufficiently motivated to calculate quantitative valuations. As professional investors, on average, rely on 3.59 valuation methods per operation (Grivillers, 2007), by not enabling such methods to be used the ecological validity is diminished.

The ecological validity is further hampered by Mussweiler and Schneller's (2003) dependent measures. Participants were either asked to purchase or sell shares given information on a number of firms. While these questions were designed to show how the anchor affects investment behaviour, they cannot be answered without having full information on other investment opportunities, market conditions and the portfolio that the stock will form part of. This was confirmed through feedback from multiple professional investors on a pilot study conducted as part of the present experiment.

Even with these shortcomings, the research by Mussweiler and Schneller (2003) provides important evidence that anchors can affect the decisions made by stock market investors. Due to the similarities between the studies, the basic research method used by Mussweiler and Schneller (2003) will be adapted for use in the present study.

2.4.2.3 Analysis of: How Much Does Expertise Reduce Behavioral Biases? The Case of Anchoring Effects in Stock Return Estimates

The third study on anchoring and investing examines how expertise affects anchoring and adjustment (Kaustia et al., 2008). As discussed previously, the effect of expertise and knowledge on investor behaviour is difficult to predict. Most research has shown that expertise does not reduce the anchoring bias (e.g. Englich et al., 2006; Northcraft & Neale, 1987), but research by Mussweiler and Strack (2000b) provides a convincing theoretical perspective on how expertise and knowledge could reduce the anchoring effect.

To measure the difference between sophisticated and unsophisticated investors, Kaustia et

al. (2008) conducted three experiments. All three experiments made use of financial experts sampled at educational seminars, while the last two experiments also made use of students with stock market experience.

In the first experiment, two experimental conditions were used: A non-disclosed condition in which participants were asked to estimate the mean annualised real stock return over the next twenty years and a disclosed condition in which participants were told the historical mean annualised real stock return was 4.5% before being asked to estimate the return over the next twenty years (Kaustia et al., 2008). The disclosed condition thus acted as an anchor, while participants in the non-disclosed condition served as a control group. The researchers also measured how relevant participants found the information on past returns.

The results from the first experiment (Kaustia et al., 2008) showed that participants in the disclosed condition estimated the future real returns to be significantly closer to the anchor (mean = 4.62%) than participants in the non-disclosed condition (mean = 8.05%). These findings are consistent with those of Welch (2000) which showed that financial experts rely heavily on estimates of historical returns when forecasting future returns. Kaustia et al. obtained a similar finding: Participants in both in the disclosed and non-disclosed conditions stated that past returns are very important when making estimates of future returns (Kaustia et al., 2008). This severely undermines the hypothesised presence of an anchoring effect as participants purposefully based their answers on past returns. Interestingly, participants in the disclosure condition who reported relying very little on past returns provided the same answers as participants who reported a strong use of past returns. While this is more in line with an anchoring explanation, it seems unlikely that these participants did not use the past returns information at all since the past returns information was the only information they were provided with. That participants were not provided with any additional information makes the study dissimilar to typical information-rich environments in which investors would make decisions.

Kaustia et al. (2008) hypothesised that participants in the no-anchor condition would make use of a self-generated anchor based on their knowledge of past returns. While it is true that more than half the participants in this condition reported that past returns is an important figure to use when forecasting future returns, this is not evidence of an anchor being generated but rather of pre-existing knowledge being actively used. Furthermore, there is no evidence to suggest that the participants who did not believe that past returns are important in forecasting future returns would anchor on a self-generated anchor of past returns. Epley and Gilovich (2001) suggest that self-generated anchors are used when participants anchor on an informative figure which they know to be wrong. As these participants do not see past returns as informative, they are unlikely to anchor on it. As such, it would be more accurate

to see this condition as a control condition, which would explain the disparity between its results and the anchor condition's results.

The second experiment also made use of two conditions: a high anchor condition and a low anchor condition (Kaustia et al., 2008). Participants in the high anchor condition were provided with information showing that Sweden experienced 20% annualised mean real returns from 1980 to 2000. Participants in the low anchor condition were provided with information showing that Japan only experienced 2% real returns per year during 1984–2004. In accordance with the classic anchoring paradigm, participants were then asked to compare the anchor with the coming twenty year annualised mean real returns before providing an absolute estimate.

The results of the second experiment showed a significant anchoring effect among both students and professionals (Kaustia et al., 2008). However, the anchoring effect exhibited by students was considerably larger than the anchoring effect exhibited by professionals. This finding can be best explained by Mussweiler and Strack's (2000b) theory on probability distributions. Since investment decisions are inherently uncertain (Shiller, 1999), both professional investors and students showed a significant anchoring effect. However, investors had a reasonable framework which could inform their estimates. In contrast, students with little experience were uncertain as to what mean annualised returns could be and thus relied on the anchors more heavily. Of the three experiments conducted by Kaustia et al. (2008), the second experiment is the most relevant to the present study as it shows how decision making can be anchored in an investment context and also highlights how expertise and knowledge could mitigate the anchoring effect.

The third experiment examined if a semantic priming activity could influence subsequent assessments of annualised mean returns (Kaustia et al., 2008). While the researchers erroneously refer to this experiment as an experiment on basic anchoring effects, no anchor is used, making it more similar to semantic priming experiments than anchoring and adjustment. As such, the experiment will not be discussed.

2.4.2.4 Analysis of: Does the Price Influence the Assessment of Fundamental Value?

Experimental Evidence

In their 2009 study, Marsat and Williams investigate whether the price of a share can act as an anchor in judgements of fundamental value. Fundamental value is determined by examining the characteristics of a firm, including its past and future assets and earnings (Graham & Dodd, 1951). The price of a share, although usually related to the share's fundamental value (Fama, 1965), should not be used when calculating its fundamental value (Rutterford, 2004). As such, price can be seen as an uninformative anchor when determining

the value of a firm.

To examine whether investors anchor on share price when determining a firm's value, the researchers made use of three experimental conditions (Marsat & Williams, 2009). In the first condition, participants (students completing a master's degree in finance or accounting) were provided with all the relevant information on a firm and asked to value it. Participants in this condition were not provided with a share price. In the second condition, the researchers provided participants with all the information presented in the first condition as well as with the share's actual price. The final condition was the same as the second except that the share price was increased dramatically to serve as a high anchor.

When asked to estimate the fundamental value of the share, participants in the no anchor condition provided a median estimation of 21.5. When the actual price was given as an anchor, the median estimation increased to 26.0, and in the high anchor condition, the median estimation increased to 39.1. These results show that participants assimilated estimates of the value of a firm towards the firm's price, and as such, are consistent with an anchoring and adjustment explanation (Marsat & Williams, 2009). The study also shows how an uninformative anchor can bias investor's judgements and how anchoring can occur in an information-rich environment. Furthermore, the information participants were provided with mirrored the information typically given to investors by analysts, so participants made their decisions using information similar to what they would use in everyday investment decision making.

One limitation with Marsat and Williams's (2009) research is its dependence on a student sample. Although the researchers used a sample of post-graduate students, the researchers do not discuss any experience that the students might have in appraising companies in real-world contexts. As was shown by Kaustia et al. (2008), there are statistically significant differences between investors and finance students making it possible that participants higher in expertise would have shown a smaller anchoring effect. As with the research by Mussweiler and Schneller (2003), the researchers failed to include a measure of the informativeness of the anchor. As such, it is difficult to say if anchoring took place or if participants erroneously used the share price in their evaluation. The present study would like to expand on the research by Marsat and Williams by including a measure of the informativeness of the anchor into the experiment.

2.4.2.5 Analysis of: Speculative Bubbles Dynamics and the Role of Anchoring

The final study conducted in an investment context was presented as a paper at the European Financial Management Association Conference (Williams, 2010). As no model has sufficiently explained the occurrence of bubbles, Williams hypothesised that anchoring and

adjustment could be used to explain bubbles. More specifically, the researcher hypothesised that investors anchor on stock prices when evaluating the intrinsic value of a share, leading to small share deviations being exaggerated. That people anchor on prices when evaluating value was shown by Marsat and Williams (2009).

The paper looks at whether anchoring and adjustment could lead to speculative bubbles in the stock market by using a series of Monte Carlo simulations (Williams, 2010). The simulations make use of two types of investors: Fundamental traders who are affected by the anchoring bias, and noise traders who invest irrationally. The strength of the anchoring bias, or investors' dependence on current prices, was systematically varied between simulations. In the no anchoring condition, fundamental traders were unaffected by the current price and simply invested according to the intrinsic value of the share. In contrast, when anchoring was high, participants' assessments of the value of the share were influenced by the price of the share, leading to biased investments. The researcher further manipulated the model so that the anchoring effect increases in size as the price moves further away from the share's value, as he hypothesised that participants would exhibit a stronger anchoring effect in order to reduce cognitive dissonance (Festinger, 1957).

With a model designed on these principles, the researcher conducted 10,000 simulations (Williams, 2010). In the no anchoring condition, Williams found no evidence of large bubbles. The largest overvaluation in his tests was 20.66% while the largest undervaluation was 16.21%. In the low anchor condition, these percentages shifted to 30.84% and 22.25%. In contrast, when investors were assumed to exhibit strong anchoring effects, the size of the speculative bubbles grew dramatically, reaching a high of 128.17% and a low of -50.84%. From these results, the researchers conclude that large speculative bubbles cannot be caused purely by noise. Instead, a large anchoring effect is required.

Williams (2010) presents a convincing explanation for the existence of stock market bubbles. Investors anchor on the price which results in trends, which initially occurred due to noise, continuing. The further the price moves away from value, the more investors justify the price and the less they rely on fundamentals—the *Dot Com Bubble* is a good example of such behaviour (Shiller, 2000). As such, fundamental traders who anchor on share prices provide sustainability for the trends caused by noise traders, ultimately leading to long-lasting and substantial differences between price and value.

While this explanation for bubbles is appealing, there are some assumptions of the research that require additional testing. Most notably, the researcher assumes that more implausible anchors lead to larger anchoring effects (Williams, 2010). While this assumption makes sense within the investment context where price could be seen as an informative anchor, it

contradicts all research done on extreme anchors (for a review, see Chapman & Johnson, 2002). According to anchoring research, the more extreme an anchor becomes the smaller its proportional effect. It is unclear if Williams' findings would be repeated without this assumption. This assumption becomes especially tenuous when the difference between the price and value becomes significant enough, as investors eventually rely almost entirely on the anchor to determine the value of a share. To the knowledge of the present author, no research has shown that anchors can have an anchoring effect this significant.

The problem with the cognitive dissonance assumption made in the study (Williams, 2010) is exacerbated by the lack of an investor sample. A sample could have provided empirical evidence for the anchoring effect being strengthened as the anchor becomes more extreme, but without the sample, such an effect is pure speculation. As such, it has to be concluded that while Williams provides a good theoretical model for the formation of bubbles, it is not grounded in past research and as such requires greater empirical support.

2.4.3 Anchoring in the market

Outside of the experiments on investors discussed in the previous section, many researchers have examined the impact of anchoring and adjustment on topics related to the marketplace. While the findings from, for example, a supermarket cannot be applied directly to a stock market setting, it should give some clues as to how anchoring can affect stock market decisions. As such, both the findings and the implications of these studies will be examined. This section will be divided into studies looking at how anchoring affects appraisals, willingness-to-purchase (WTP) and willingness-to-accept (WTA), and negotiations.

2.4.3.1 Appraisals

The most famous study on anchoring and appraisals, and one of the seminal studies of anchoring and adjustment, was conducted in 1987 by Northcraft and Neale. Northcraft and Neale did an experiment on the effects of anchoring and adjustment on the valuation of real estate. Their experiment is important today for three reasons: (1) It was one of the first experiments to examine the effect of anchoring and adjustment outside of a laboratory setting; (2) it was one of the first experiments done on professional decision makers in their natural decision making environment; and (3), it showed an anchoring effect in an information-rich environment. All these characteristics are central to the present study, making the work by Northcraft and Neale particularly relevant.

In order to examine the effect of anchoring and adjustment on the decision making of real-estate agents, the researchers invited a sample of students and estate agents to a house that was on the market at the time. The participants were presented with a ten page packet

containing all the information estate agents would need to appraise the property. Included in the information packet was a listing price which served as the anchor. Participants were then divided into four conditions: low price, moderately low price, moderately high price, and high price. In the two moderate conditions (moderately low price and moderately high price), the listing price differed from the actual listing price by roughly 4% (a significant amount according to experts; Northcraft & Neale, 1987), while in the extreme conditions (low price and high price), the price differed by roughly 12%. All other information was kept constant. After visiting the house, participants were asked to value the property and to list the information they took into consideration when choosing the values. The experiment was conducted twice, each time with a different property and a different sample.

The researchers found that both experts and amateurs were significantly affected by the listing price when valuing the properties (Northcraft & Neale, 1987) and that the extreme anchors resulted in a proportionally greater bias. However, it should be noted that while Northcraft and Neale refer to these anchors as extreme anchors, they differed only 12% from the actual listing price making them plausible, rather than extreme anchors. With regards to the information participants took into consideration, a quarter of the amateurs mentioned the listing price as one of their top three concerns and only one-seventh of the professional estate agents did.

The most important conclusion that can be drawn from the research by Northcraft and Neale (1987) is that anchoring and adjustment can have an impact on everyday decisions, including financial decisions. At the same time, the study highlights some of the problems inherent in doing anchoring and adjustment research in a real world environment. For anchoring and adjustment to occur, participants cannot purposefully use the anchor to inform their decisions. In Northcraft and Neale's experiment, 56.2% of amateurs and 24.0% of professionals in experiment 1 considered the listing price when valuing the house, while 22.9% of amateurs and 14.3% of professionals listed it as one of their top three considerations. Any plausible anchor thus has the inherent threat of being taken seriously and affecting the price without the use of heuristics. However, by asking whether participants took the anchor into consideration when making a decision, the effect of the purposeful use of the anchoring information can be removed from the final results using regression analysis. A second important finding by Northcraft and Neale (1987) is that anchoring can occur when participants are provided with a large quantity of information. This finding has been repeated since, but this study still highlights both the strength of the anchoring effect, and its ability to impact real life decisions in information-rich settings.

2.4.3.2 Willingness-to-purchase and willingness-to-accept

WTP and WTA are two factors closely related to the appraisal of an asset. WTA is the lowest price that sellers are willing to accept for a product they are selling, while WTP is the highest price that consumers are willing to pay for a product they wish to purchase (Simonson & Drolet, 2004). In an investment situation, WTP would be the price that investors are willing to pay for a share, while willingness to accept would be the price at which investors are content to sell shares at.

In a study on valuations and WTP, Ariely et al. (2003) show how product valuations can be anchored by both irrelevant factors and prior valuations. The researchers conducted six experiments. The first experiment showed how an irrelevant anchor (participants' social security numbers) could affect the bids they made on consumer products. Participants with social security numbers in the top quintile were typically willing to pay three times more for products than participants with social security numbers in the bottom quintile. That WTP is as sensitive as it is leads the researchers conclude that participants typically do not have a fixed, pre-existing price for many products. Instead, participants are likely to have a range of prices for products (for example, they are willing to pay between R25 and R175 for a bottle of wine) and anchors cause the WTP to shift within this range. This should be especially true in investment situations, where environmental changes can affect the prospects of a firm on a daily basis.

Based on the idea of a range of prices, the researchers make three hypotheses: (1) when there is no precedent, people's WTP will be very sensitive to extraneous factors; (2) past purchases can act as an anchor for future purchases; and (3) a series of related purchase decisions by a participant will be coherent. These hypotheses were tested in the next five experiments.

The second experiment confirmed the first and third hypotheses (Ariely et al., 2003). Participants were presented with a painful experience (an annoying sound) and asked whether their WTA was higher or lower than either a high monetary anchor (50c) or a low monetary anchor (10c). The researchers found that participants in the high anchor condition consistently had a higher WTA across multiple trials than participants in the low anchor condition. The responses from participants in the two conditions never converged, showing strong coherence in participants' WTA. The third experiment obtained the same results with higher stakes. The fourth experiment tested if market forces would make the WTA from the high and low anchor conditions converge. Participants were put in an auction situation where the painful stimulus was awarded to only the best bids. Participants from both the low and high anchor conditions participated in the same auction. The researchers found no evidence

that the WTA from the two conditions converged. In fact, the researchers found that the market forces increased the strength of the anchoring effect. The anchor thus shaped participants' appraisal of the stimulus and participants would rather ask too much for the product than sell it for a price below their appraisal. The fifth experiment tested whether previous decisions anchored subsequent ones. The researchers used a similar design to the second experiment but provided participants with a new anchor after each trial. From the results, the researchers conclude that the first anchor had a greater effect on both the second and third question than the more recently presented anchors, highlighting how previous choices can anchor future decisions. The sixth and final experiment tested whether these findings held for non-monetary incentives. The results confirmed that it did. The results further showed that consistency in one field does not translate to other fields, which is to say that participants whose WTA for an annoying noise was 50c would not necessarily have a WTA of 50c for an equally painful but different experience.

Even though these experiments were conducted in an unconventional market, the results may hold important implications for investors. First, it shows that arbitrary anchors can significantly affect financial decisions (Ariely et al., 2003). Second, it indicates that anchoring is fairly resistant to market forces, at least in uncertain markets. A third implication of the research by Ariely et al. is that past purchases can anchor subsequent decisions. As such, an investor who previously purchased SASOL shares at 35000c may use this as an anchor when evaluating future decisions regarding SASOL shares. If the share price dropped significantly, the investor evaluating the share might anchor on the past price, leading to an inflated expectation of value, while shares that rapidly increase in price might lead to investors feeling that the share is overvalued. At the same time, the research by Ariely et al. (2003) also highlights the need for anchoring studies to examine the effect of anchors on commonly traded shares. The research by Mussweiler and Schneller (2003) and Marsat and Williams (2009) both used firms that participants did not know, as this provided more control over external influences. However, using such firms fails to evaluate how pre-existing anchors would interact with new anchors in the stock market.

According to research by Simonson and Drolet (2004) the anchoring effect in WTA and WTP depends critically on participants' uncertainty regarding their willingness to trade. The researchers found that anchoring had a significant effect on WTP and WTA, except when participants had already decided to sell their product before being presented by an anchor. Simonson and Drolet suggest that when participants decide to sell a product they anchor on the market price which then influences their appraisal of the product. As was shown by Ariely et al. (2003), initial anchors exert a much stronger effect than subsequent anchors. As such, the market price would exert a much greater effect on sellers' WTA than any subsequent

anchors. On the other hand, when participants are anchored on an irrelevant anchor before deciding to sell the product, they appraise the product based on this anchor before looking at market conditions.

Simonson and Drolet's (2004) research suggests that investors who first look at the market conditions will be relatively unaffected by an irrelevant anchor (such as a company spokesperson's prediction). Although some studies on anchoring did present information on market conditions, it is unclear how prominently information on WTP was presented. For example, in Mussweiler and Schneller (2003) participants were presented with a chart including a salient high or low, as well as information on market conditions. While the chart would have included the most recent closing price, and thus a good estimation of WTP, if the past price was more salient than the present price, it would explain why participants anchored on the past price rather than on the present price.

In a final study on anchoring and WTA and WTP, the researchers found that basic anchoring effects can only bias judgements when the basic anchor is repeated multiple times (Wu et al., 2010). The researchers conclude that when the comparative question is ignored, the anchor has to be made salient in another way. It should be noted that this is only true for completely irrelevant anchors. Anchors which are salient comparison standards, such as past prices, are likely to have an anchoring effect even without a comparative question (as was illustrated by Northcraft & Neale, 1987). The results from Wu et al. (2010) do, however, provide assurance that semantically irrelevant and incidental numbers are unlikely to affect investment decisions in a systematic way.

2.4.3.3 Negotiations

A final economic field in which anchoring and adjustment has been researched is negotiations. Although stock market investing involves very little negotiating, the findings from negotiations research are relevant to stock market investing. Specifically, research on negotiations shows how anchors which are known to be unreliable can still affect asset valuation. In negotiations, neither party has an obligation to provide the opposing party with a reasonable offer (see, for example, Churchman, 1995). As such, participants in a negotiation have no expectation that the first offer will be either fair or representative, yet these offers can still act as anchors.

In one of the first studies on anchoring and adjustment and negotiations, Ritov (1996) made use of a competitive market simulation to test the effect of first offers on negotiations. Most texts on negotiation tactics suggest allowing the other party to make the first offer. However, Ritov found that the outcome of negotiations was highly correlated with the first offer due to the anchoring effect. These findings were later repeated by Galinsky and Mussweiler (2001)

and Galinsky et al. (2009).

Research done by Galinsky (Galinsky & Mussweiler, 2001; Galinsky, Mussweiler, & Medvec, 2002; Galinsky et al., 2009) expanded on the original findings of Ritov by looking at ways in which the anchoring effect can be counteracted. In Galinsky and Mussweiler (2001), the researchers found that thinking about reasons why the opponent's offer is unreasonable nullified the anchoring effect (in line with the consider-the-opposite technique; Mussweiler et al., 2000). This included thinking about the alternatives the opponent has available (as they serve as the opponent's lower bound), the opponent's reservation price (the maximum or minimum price at which they would be willing to conclude the negotiation; Raiffa, 1982) and information on the offer you would most prefer. In a second study, Galinsky et al. (2002) showed how negotiator focus affected negotiation outcomes. When negotiators focused on the prices they wished to achieve, rather than on their own reservation prices, outcomes were considerably more favourable suggesting a diminished anchoring effect.

Together, these studies make a few important points. First, anchors which participants know to be deceptive and exaggerated can still lead to biased financial decision making. While this might be assumed from studies on extreme and implausible anchors, very few studies have looked at the effect of anchors that participants know from the start are intended to deceive and bias. Second, such anchors (and the focus of the decision maker) substantially affect people's perceptions and goals. Participants in Galinsky et al. (2002) were unhappy with an objectively better result because the anchor affected their appraisal of the product. Finally, it shows how the consider-the-opposite debiasing technique (Mussweiler et al., 2000) can be used to improve financial decisions.

2.4.4 Anchors in the investment context

Most research on investors has focused on testing the role of a specific anchor, such as a salient past price on a stock chart (Mussweiler & Schneller, 2003), a share's current price (Marsat & Williams, 2009), or past stock return estimates (Kaustia et al., 2008), on decision making. In order to avoid the anchoring effects present in investment decisions, it is important to have a good awareness of the anchors present in an investment context. Furthermore, the potential anchors available should inform which debiasing method is used. Salient past prices may be debiased by having investors list reasons why the share's current price is an accurate depiction of the share's worth, but not without anchoring participants on the share's current price. The following section will look at some of the most prominent anchors that occur in the investment context.

Before looking at the anchors, it should be noted that not only uninformative anchors can hamper investment decision making. Informative anchors can negatively influence

investment decisions if too much weight is given to the anchors (Chapman & Johnson, 2002). This was specifically shown by Williams (2010) in his study on share price as an anchor. While many investors rely on share prices to provide an indication of the value of a share, Williams showed that share prices could lead to speculative bubbles when given too much weight.

2.4.4.1 Opinions and conversational anchors

One of the most direct sources of anchors is conversations. Statements like “Do you think SASOL will break 40,000c this year?” or “The price of Brent Crude will never go over \$100 again,” are commonly heard by investors. The investment environment is filled with opinions and predictions by analysts, company spokespersons, and other investors, all of which could serve as anchors in investment decisions. As analyst forecasts should be the most informative of these anchors, they will be discussed first.

While analyst predictions are often informative (Myring & Wrege, 2009), it is prudent to note that analysts are as prone to the anchoring bias as investors (De Bondt, & Thaler, 1993). Research has also found analyst forecasts to be overly optimistic, especially during bubbles (Dreman & Berry, 1995; Stickel, 1990), and especially when the brokerage firm is affiliated with the specific share being analysed (Lin, & McNichols, 1998). Further research has shown that brokerage firms implicitly reward analysts for being overly optimistic, as this leads to increased business and trading commissions (Hong & Kubik, 2003). Both during and after the dot-com crash, many top analysts continued advocating the inherent value of internet shares (Hong, 2004).

In contrast to analysts, company spokespersons are under no obligation to present fair or unbiased forecasts. Being directly affiliated with a specific firm is likely to lead to a systematic optimistic long-term bias (Lin, & McNichols, 1998). The effects of reporting bias, where people or companies are more likely to report positive news, should also not be discounted (Fischer & Verrecchia, 2000). Further research has shown that even something as objective as financial reports are often framed in a way as to lead to a more positive analysis of the firm’s prospects (Andersson & Hellman, 2007; Marquardt & Wiedman, 2004).

Taken together, these biases undermine the informativeness of stock market opinions, especially when compared with an analysis of a firm’s fundamentals. Yet, research on selective accessibility implies that any salient opinion or prediction could bias investors’ appraisals of a share and that such a bias could last for a time period of over a week (Mussweiler, 2001). This remains true even when the anchor is extreme or clearly biased, as was shown in studies on negotiations (e.g. Ritov, 1996). However, as was indicated by the research of Simonson and Drolet (2004) and Ariely et al. (2003), these anchors are likely to

be less effective the later they are encountered in the research process. This is to say that investors whose interests are piqued by an optimistic opinion are more likely to be affected by a conversational anchor than an investor who has followed and researched a share significantly before encountering the conversational anchor. Not only is the anchor more salient for investors introduced to the share by the analyst, but it creates a pervasive appraisal which is resistant to subsequent influences (Ariely et al., 2003).

Predicting the effect of any single investor anchoring on an opinion is difficult to do as it will depend on content of the opinion. However, when aggregated, the majority of opinions should reflect the market sentiment, and anchoring on such opinions should thus lead to herd behaviour.

2.4.4.2 Share prices

With the ambiguity inherent in the value of firms, share prices serve as a prominent anchor when evaluating present and future value (Shiller, 1999). Northcraft and Neale (1987) showed how irrelevant prices affected judgements in a much less ambiguous situation which made the results of Mussweiler and Schneller (2003) unsurprising.

Two theoretical approaches define the role of share price in the stock market. According to the theory of fundamental value, a firm's value is determined by a combination of expected cash flows, its net book value, and an assessment of the firm's intangible assets (Marsat & Williams, 2009). A share's price is thus irrelevant when calculating its value, and if the value is higher than the current price, the share should be purchased. The second theoretical model, the efficient markets hypothesis, argues that all knowledge about the value of a share is already included in its price, and as such, past prices are irrelevant to future prices (Lo, 2007). Although these theories have been supported in research (Fama, 1991), they are primarily normative rather than descriptive theories and their practical application has been questioned (for example, see Lo, 2004)

According to both the theory of fundamental value and efficient markets, past prices are irrelevant when estimating current value and, as such, should be ignored. That investors fail to do so was first shown by Mussweiler and Schneller (2003) before Marsat and Williams (2009) repeated the results. What is more, Williams (2010) provided a theoretical model of how anchoring on past prices could lead to speculative bubbles. Both past and present prices are thus irrelevant but highly salient anchors which have a strong effect on future decisions. This includes visual representations of past prices such as stock charts, but also salient milestones such as the price at which a share was originally purchased. Avoiding these anchors may be impossible for most investors.

2.4.4.3 Trends

Fama (1965) begins his famous paper on the efficient markets hypothesis with the following question: “To what extent can the past history of a common stock’s price be used to make meaningful predictions concerning the future price of the stock?” (p. 34). He concludes his paper with the assertion that the stock market takes a random walk, meaning that past prices and trends are uninformative when forecasting future prices and trends.

In contrast with the random walk hypothesis, and consistent with an anchoring and adjustment explanation, research has shown that investors tend to focus on trends when forecasting price movements (Case & Shiller, 1990; DeBondt, 1993). In a phenomenon similar to anchoring on past prices, anchoring on trends leads to herd behaviour which amplifies the effect of small changes in share values (Scharfstein & Stein, 1990) ultimately leading to volatility in the market (Lux, 1995).

In some situations, trend-following behaviour can be efficient in stock markets (Lo & MacKinlay, 1988). However, these findings are typically very short term—Lo and MacKinlay found positive serial correlation in weekly returns. Over longer periods of time, trends are more likely to be negatively autocorrelated than not (De Bondt & Thaler, 1989; Fama & French, 1988). As such, following trends for any significant period of time is more likely to be harmful than beneficial to the investor.

It should be noted that while anchoring was originally conceived as adjustment from a numerical anchor, a trend can just as easily be anchored on according to the selective accessibility model. As long as the trend is salient and activates information consistent with it, it can anchor future estimates.

2.4.4.4 Previous purchase decisions

As mentioned earlier, purchase decisions can raise the salience of a specific price, making it a more likely anchor. However, purchase decisions can also lead to a phenomenon called *conservatism* in which individuals, after making a decision, fail to sufficiently take new information into consideration (Edwards, 1968). Conservatism has been linked to anchoring and adjustment in the past (e.g. LeBoeuf & Shafir, 2006). People anchor on the decisions that they have made, leading to an increase in the accessibility of information supporting their decisions and thus an underweighting of new information.

The effect of previous purchase decisions (as well as the other anchors discussed) on future decisions is two-fold. First, previous purchase decisions bias subsequent appraisals of the share. When making purchase decisions, investors activate a lot of information supporting their decisions. Any information that dramatically changes the value of the share will thus

need to compete with the already activated information when subsequent decisions are made. As such, subsequent forecasts, valuations, and purchase decisions will all be influenced by the information already activated. Second, previous purchase decisions lead to a status quo bias (Kahneman, Knetsch, & Thaler, 1991; Samuelson & Zeckhauser, 1988) where an individual's valuation of a share supports its purchased price, even when new evidence is discovered. The same bias occurs when investors anchor on popular opinions, as these opinions, on average, will support the status quo, and also when investors anchor on trends, as activated information will support the continuance of such a trend. As such, these anchors undermine the valuation of a share according to its fundamental value, while supporting factors unrelated to fundamental value.

2.4.4.5 Risk and reward evaluations

In their original study on anchoring and adjustment, Tversky and Kahneman (1974) showed how anchoring and adjustment leads to problems in assessing conjunctive and disjunctive probabilities. In investment situations, these problems can manifest as biases when assessing future probabilities. For example, investors anchoring on the very large possibility that the status quo will be maintained may underestimate the probability of unlikely but catastrophic events occurring, given enough time. This idea is discussed in some depth by Taleb (2007). Outside of affecting assessments of extreme outliers, research by Tversky and Kahneman shows that any situation in which conjunctive or disjunctive probabilities need to be calculated could be prone to the anchoring bias.

Risk evaluations are similar to *best- and worst-case* anchors, where participants anchor on best- or worst-case scenarios (Epley & Gilovich, 2010). When investors anchor on the worst that could occur in the market, they are likely to activate information making such an occurrence seem more likely. Similarly, when participants anchor on best-case scenarios, they are likely to ignore important risks in the undertaking.

Taken together, the anchors discussed here give a good idea of the prevalence and diversity of investment anchors. They also highlight the negative effect that anchoring could have on investment decisions, and the importance of finding debiasing methods. The following section will look at potential debiasing methods in the investment context.

2.5 Debiasing

Arnott (2006) defines debiasing as a “procedure for reducing or eliminating biases from the cognitive strategies of a decision-maker” (p. 62). According to Wilson and Brekke (1994), four conditions need to be met for a heuristic to be debiased: (1) Participants must be aware of the bias and know when it occurs; (2) participants must purposefully aim to correct the bias; (3) the direction and size of the bias must be known to participants; and (4) participants

must be able to exert control over their responses. Rather than providing researchers with a starting point in debiasing anchoring and adjustment, Wilson and Brekke provides researchers with a list of obstacles. To highlight the problems with debiasing anchoring and adjustment, it is worth individually looking at the conditions required for debiasing.

The first condition listed by Wilson and Brekke (1994) is that participants must know when the anchor occurs. In studies using the classic anchoring and adjustment paradigm, knowing when a bias will occur is easy. Participants faced with Tversky and Kahneman's (1974) wheel of fortune would know when to expect the anchoring bias to occur if they had been informed about the bias beforehand. However, few real world situations present such an obvious bias. In information-rich settings like those studied by Northcraft and Neale (1987), it may be impossible for investors to decide what the anchor is and whether it has biased their judgements. Similarly, in the stock market, investors are faced with an abundance of potential anchors such as past prices and trends, and as such, it is not plausible to expect investors to be aware of all biasing influences.

The second debiasing condition listed by Wilson and Brekke (1994), motivation to correct the bias, is met by investors. As investors are financially rewarded for accurate and unbiased decisions, it can be assumed that they are motivated to overcome any bias. While incentives and motivation have not been enough to prevent bias in anchoring studies in which selective accessibility occurred (Wilson et al., 1996), they have been effective in reducing bias in studies on insufficient adjustment (Epley & Gilovich, 2005). As investors are likely to be more motivated than most experimental participants, it seems plausible that self-generated anchors will not lead to biases in investors, while externally-provided anchors will.

That investors should know both the direction and the size of the anchoring bias presents the biggest hurdle to debiasing anchoring and adjustment. Because anchoring occurs unconsciously, most participants in anchoring studies are unaware of any anchoring effect (e.g. Englich et al., 2006; Wilson et al., 1996). Even when participants are made aware that an anchoring effect has occurred, participants are uncertain about both the magnitude and the direction of the effect. In a study by George et al. (2000), participants who were informed that their estimates were biased by anchoring and adjustment provided new, lower estimates in both the high and the low anchor conditions. Because participants were unaware of the direction of the bias, they increased the bias in the low anchor condition but decreased it in the high anchor condition.

The final condition for debiasing, that participants must have control over their responses (Wilson & Brekke, 1994), poses the last problem for researchers attempting to debias anchoring and adjustment. While individuals affected by anchoring and adjustment do have

control over the decisions they make, they typically do not have control over the information they activate and thus the information their decisions are based on. Participants can thus make objective decisions based on the information at hand, but since the information available is often out of their control, they cannot be said to have full control over their responses.

As such, investors meet only one of the conditions required for debiasing (motivation for change) with at least two conditions either rarely attainable or completely out of their control. The following section will focus on debiasing suggestions that have been made, and investigate how they interact with the conditions required for debiasing. As will be shown, because of the investment conditions discussed earlier, few debiasing strategies are likely to be effective.

2.5.1 Consider-the-opposite

One of the most common methods to overcome a distorted knowledge base is the consider-the-opposite method where participants consider a point of view in direct opposition with their biased knowledge base (Lord, Lepper, & Preston, 1984). By looking at evidence in opposition with their knowledge base, participants activate information contradicting their knowledge pool allowing the subsequent judgement to be based on less biased information (Chapman & Johnson, 1999). The consider-the-opposite strategy has been effective in reducing the effects of multiple biases that result from a distorted knowledge pool, including overconfidence (Koriat, Lichtenstein, & Fischhoff, 1980) and the hindsight bias (Arkes, Faust, Guilmette, & Hart, 1988).

To test the effect of consider-the-opposite on anchoring and adjustment, Mussweiler et al., (2000) asked half the participants in an experiment to list reasons why the anchor was unrealistic while the other half served as a control group. The researchers found that listing information contrary to the anchor mitigates the effects of the anchoring bias with the results indicating a significant difference between the consider-the-opposite and control conditions. The findings also suggested a strong negative correlation between the size of the anchoring bias and the number of counter-arguments listed. Experts who considered the opposite did, however, still show a significant anchoring bias. These results were repeated in a second experiment by Mussweiler et al. (2000). However, the consider-the-opposite group from this experiment showed no bias, while a group of participants listing anchor consistent reasons showed an even stronger bias. In another experiment, Chapman and Johnson (1999) found that prompting targets to identify features inconsistent with the anchor debiased the anchoring effect, while Chandon and Wansink (2007) found similar results in an ecologically valid setting. Galinsky and Mussweiler (2001) found consider-the-opposite to be effective at

decreasing the anchoring effect in financial decisions.

Multiple conclusions can be drawn from these experiments. First, the consider-the-opposite technique is effective at mitigating the effects of anchoring and adjustment. However, when anchor-consistent reasons were generated, the anchoring bias was strengthened. Participants asked to generate anchor-consistent reasons thus consider new information which is added to the already biased knowledge pool. As such, it can be concluded that the consider-the-opposite effect is additive with the anchoring effect, as the information it adds to the knowledge pool directly adds to or subtracts from the bias (Mussweiler et al., 2000). When participants list anchor-consistent information, the anchoring bias is strengthened, while anchor-inconsistent information debiases the knowledge pool.

The additive nature of the consider-the-opposite effect presents a concern for investors. Rather than strictly decreasing the effect of the bias, the consider-the-opposite technique adds biased information that, hopefully, contradicts the initial information to participants' knowledge pool. However, as investors are often unaware of the anchor—and thus the direction and magnitude of the anchoring effect—it is difficult to consider knowledge contradicting the anchor. Participants are thus as likely to increase the anchoring bias by considering new reasons as they are to diminish it. For example, in Mussweiler et al.'s (2000) second experiment, participants in the high anchor group that produced anchor-inconsistent reasons provided final judgements very near to those in the low anchor group that did not provide any reasons. Similarly, Chandon and Wansink (2007) found that participants often *overcorrected* when using the consider-the-opposite technique. As such, the consider-the-opposite technique can lead to a semantic priming bias in the opposite direction. It is thus important to identify situations in which consider-the-opposite can effectively be used in an investment environment. A potential example is when investors anchor on a salient trend. As the anchors and its direction are known in these situations, consider-the-opposite could be an effective debiasing technique.

2.5.2 Decision support systems

A decision support system (DSS) is a “computerized aid designed to enhance the outcomes of an individual's decision-making activities” (Singh, 1998, p. 145). Decision support systems are often effective at debiasing decisions makers (Bhandari, Hassanein, & Deaves, 2008; Evans, 1989), especially when judgements are systematically and predictably biased.

In a study on decision support systems and anchoring, George et al. (2000) duplicated the research method used by Northcraft and Neale (1987) but added a computerised warning message when participants provided answers too close to the original anchors. As with other studies on forewarnings (e.g. Wilson et al., 1996) the researchers found no significant

reduction in the anchoring bias. Instead, participants in both the high and low anchor conditions who received warnings decreased their estimates. This highlights the problem with using decision support systems to debias the anchoring effect. As participants were unaware of the direction and magnitude of the anchoring bias, a warning message forced participants to adjust blindly. As the values in an investment market are inherently uncertain, and the anchors typically ambiguous, researchers have no way of providing accurate information on the size or direction of the bias.

Decision support systems might, however, be useful in situations where the anchor is clear and objective markers are readily available, specifically when used in conjunction with other debiasing strategies. For example, investors intent on purchasing shares at a price significantly removed from the firm's fundamental value (or a rough computerised estimate of it) might be prompted to list reasons why the current share price is too high, or why the fundamental value of the firm is an accurate portrayal of the share's worth. However, as with the consider-the-opposite debiasing strategy, decision support systems will only be efficient at debiasing the anchoring effect in a very limited range of situations.

2.5.3 Decreasing uncertainty

In a study on credit card repayments, Stewart (2009) suggested that participants should be provided with a table showing the effect of different repayments, reducing the uncertainty and thus participants' dependence on the minimum repayment as an anchor. As the use of anchoring and adjustment only occurs in situations of uncertainty, removing some of the uncertainty should mitigate the anchoring effect. While it is difficult to remove uncertainty from most investment situations, there may be a few situations in which such a strategy could be useful. Anderson and Settle (1996) showed that participants underestimated the effects of cumulative risk and returns over long periods of time. In situations where such forecasts can be made with relative certainty, providing participants with estimates of cumulative returns should reduce the anchoring effect. Similarly, it was shown by Tversky and Kahneman (1974) that anchoring and adjustment affects judgements of conjunctive and disjunctive probabilities. Providing investors with a best estimate probability for conjunctive and disjunctive events might also be effective. However, as with the other debiasing techniques, reducing the uncertainty will have limited uses.

2.5.4 Avoid the anchor

Epley and Gilovich (2005) suggest that an effective debiasing strategy might be to avoid the anchor altogether. While extreme on the surface, avoiding the anchor might be the easiest way to avoid an anchoring bias. Many anchors found in investment situations (such as stock charts) are considered irrelevant by normative theories of investing. Investors are actively

advised against using them. As such, these anchors could be removed from private investment firms without hampering decision making.

There are, however, two limitations to avoiding the anchor. First, the prevalence of these irrelevant anchors might make them difficult to avoid outside of controlled environments. For example, stock charts are often used in discussions of firms. Because of the durability of anchors (Mussweiler, 2001) these could have a significant impact on decisions made much later. The second limitation is that only irrelevant anchors can be avoided. Anchors which are informative but tend to be overweighted, such as share price, cannot be avoided.

In conclusion, the literature suggests that investors might be specifically vulnerable to the anchoring bias. Not only is anchoring very robust, the characteristics of the investment environment make investment decisions susceptible to an anchoring bias. There are multiple prominent anchors that investors will encounter in an investment context, and these anchors are expected to have a substantial effect on future decisions. Finally, no debiasing technique is expected to work for all anchors and these techniques are often as likely to introduce bias as they are to reduce it. The most promising news for investors comes from the work of Simonson and Drolet (2004) and Ariely et al. (2003) whose cumulative findings suggest that irrelevant anchors may not have as significant an effect on investors as expected.

3. Research method

3.1 Introduction

The research method used for the present study will be described in terms of seven elements: The (1) research design, (2) sampling method, (3) data collection, (4) hypotheses, (5) data analysis, (6) threats to validity and (7) ethical considerations of the study.

The research method was based on the research of Mussweiler and Schneller (2003). Participants were first presented with a content-rich description of a stock. After reading the stock's description, participants were asked to value the stock. All participants were given the same description of the share except for the stock chart which was manipulated to include either a very salient past high or low. This salient high or low acted as an anchor.

The research expands on the work by Mussweiler and Schneller (2003) in three significant ways: First, a considerably larger sample of students was used. As research on anchoring and adjustment often has significant variance, increasing the sample size was seen as a way to improve power of the test (Muchengetwa, 2010). Second, the study provided participants with the information required to make use of quantitative valuation techniques, including the valuations calculated using the dividend discount, free cash flow to equity and free cash flow to firm models. In a survey from 2007 it was found that 81% of experts rely on

discounted cash flow models to calculate intrinsic value (Grivillers, 2007). These methods are thus important to include if the experiment is to be ecologically valid. Finally, a measure of the informativeness of the anchor was included.

In the following pages, the research method will be discussed in greater depth.

3.2 Research design

A quantitative research strategy was used to examine the prevalence of the anchoring and adjustment heuristic in investors. Quantitative research focuses on obtaining numerical data which are statistically analysed to determine the strength of certain relationships (Gravetter & Forzano, 2008). As the purpose of this study is to build on the research by Mussweiler and Schneller (2003), it is important that a similar research design is used. The use of a quantitative design is also better at establishing causality (since only one variable differs between the two conditions) and eliminates subjective interpretation to a large extent, allowing the results to be compared more readily (McVilly, Stancliffe, Parmenter, & Burton-Smith, 2008).

The experiment made use of two conditions: A high anchor condition and a low anchor condition. Participants in the high anchor condition answered a questionnaire in which the stock chart contained a salient peak (Figure 1) while participants in the low anchor condition answered a questionnaire in which the stock chart had a salient low (Figure 2). Although these graphs are not identical to those used by Mussweiler and Schneller (2003), the differences are cosmetic and not believed to be significant. Only one independent variable, the anchor, was thus manipulated in the experiment. Both the high and low anchors were plausible as the goal of the research was to examine the anchoring effect in a realistic investment situation. Since the anchor is embedded in the information and participants are never actively asked to compare it to the target, the research makes use of a one-stage anchoring design.



Figure 1: The high anchor stock chart



Figure 2: The low anchor stock chart

The dependent variable was an assessment of value made by investors. Specifically, investors were asked to provide their best estimate of the firm's fundamental value. This differs from the measure of value used by Mussweiler and Schneller (2003) who had participants either estimate the future price of a share or decide on a number of shares to purchase or sell. Feedback from the pilot study showed that many investors felt that these questions could not be answered without extensive knowledge of the market. To determine how many shares to purchase or sell investors would need information on their portfolio of shares as well as a comprehensive list of other investment opportunities. By asking investors to provide their best estimate of intrinsic value, these problems were avoided.

Because there is only one independent variable and one dependent variable, an experiment design is the most suitable research design. Experimental designs allow researchers to "demonstrate a cause-and-effect relationship between two variables" (Gravetter & Forzano, 2008, p. 221). However, the level of control needed for experimental designs often decreases the ability of the research to be generalised beyond the experimental setting (Gravetter & Forzano, 2008).

3.3 Sample

A between-subjects research design was used for the experiment, with each participant only taking part in one research condition. Gigerenzer (1996) criticised heuristics and biases research for relying too heavily on between-subjects designs which fail to show that individual decisions are biased. However, a within-subjects design could not be used in the present article for the three reasons: First, presenting participants with the same questions in different conditions would have revealed the intent of the researcher which could lead to participants adjusting their responses. Second, a within-subjects design would allow

participants to detect and correct inconsistencies within their work (Kahneman & Tversky, 1996). Finally, the durability of anchoring effects (Mussweiler, 2001), as well as the coherence of preferences (Ariely et al., 2003), means that the anchor in the first condition would have an undue effect on the estimate provided in subsequent conditions. Thus, in order to eliminate testing effects (Gravetter & Forzano, 2008) a between-subjects research design was used. While the between-subjects design prevents the study from showing that any single participant's choices were biased (Kahneman & Tversky, 1996), it will reveal significant differences between the two conditions.

Two attempts were made to procure a sample of professional investment decision makers. A request was made to the Investment Analysts Society of South Africa (IASSA) for the use of their mailing list. Access was initially granted but the decision was changed at a later stage and the researchers were denied access to the IASSA members. Once the request was denied, the heads of multiple investment firms' equity departments were contacted and a request for access to their employees was made. Although two firms (Old Mutual and Prescient) acceded, the response rate was insufficient for the purposes of the study. Instead, the participants who provided feedback were contacted and the information they provided was used to improve the research instrument.

As a sample of sufficient size could not be obtained from professional investors, conveners of fourth year finance and actuarial students at the University of Cape Town were contacted and permission to use their students was obtained. The classes were chosen in such a way that no student attended both courses. Both the finance and actuarial science students had completed courses on equity valuation and were expected to be comfortable with the information provided on the questionnaire.

Because of the use of a student sample, sampling bias poses a threat to validity. A sample of students might systematically differ from the target population of professional investors. Specifically, it could lead to a sample which is less informed and experienced than the average professional investor. However, as research on anchoring has shown, both experts and amateurs are significantly affected by the anchoring bias (e.g. Englich & Mussweiler, 2001; Northcraft & Neale, 1987). Furthermore, the anchoring bias remains largely unaffected by general expertise (Englich & Mussweiler, 2001; Englich et al., 2006). As such the use of a student sample was considered appropriate and is also concordant with most studies on the anchoring bias in investors (Anderson & Settle, 1996; Marsat & Williams, 2009; Mussweiler & Schneller, 2003).

A second threat to validity inherent to the sampling method is volunteer bias. As convenience sampling was used and participation was completely voluntary, volunteer bias

could not be avoided. However, the general robustness of anchoring makes it unlikely that the typical characteristics of the volunteer (see Rosenthal & Rosnow, 1975) would significantly affect the research findings.

Participants were not offered any monetary inducements for taking part in the research. Because the experiment took minimal time and the results were directly relevant to the participants, participants were expected to participate voluntarily and out of an interest in the topic. Furthermore, research has shown that selective accessibility anchoring is unaffected by monetary inducements (Wilson et al., 1996). As Simmons, LeBoeuf and Nelson (2010) state in their article on accuracy motivation in anchoring and adjustment, the belief that individuals who are motivated by inducements would provide more accurate responses in the anchoring paradigm “has been contradicted by decades of research” (p. 918). Inducements would therefore only be useful in increasing the sample size and not the accuracy of answers. As the sample size was expected to be sufficient, no monetary incentives were offered.

3.4 Data collection

Participants were provided with the questionnaires during two compulsory lectures (*Financial Economics* and *Applied Investments*). At the start of the lectures the students were addressed briefly and informed of the purpose of the research. Participants were also informed that the survey was not expected to take longer than fifteen minutes and that the questionnaires had to be completed under test conditions. Finally, in line with the APA code of ethics (section 8.02; American Psychological Association, 2010), participants were informed that participation in the survey was not compulsory. While the students were being addressed, research assistants handed questionnaires out. The questionnaires were shuffled in such a way that a low anchor questionnaire was always followed by a high anchor questionnaire and vice versa.

Dillman (2007) suggests starting questionnaires with questions which are both interesting and easy to answer even if these questions are not necessitated by the research. As such, each questionnaire was started with four questions on the perceived importance of information on biases in stock market investing. After answering the introductory questions, participants received the following instruction: *Please read through the following description of a share before providing your best estimate of intrinsic value*. Participants were then presented with a full docket of information on a fictional share (AB Foods) which included the company's background, an analysis of its financials, four fair value estimates calculated using the financials, and a stock chart containing the high or low anchor (the full questionnaires can be found in *Appendix A*).

The information participants were provided with was based on the professional equity analyst reports of four prominent retailers. The content was designed to be ambiguous and thus contain information supporting both low and high anchors. A pilot study conducted on professional investment analysts revealed that the information provided by Mussweiler and Schneller (2003) would be insufficient for investment decisions. Based on the feedback provided by the analysts, the information required for three quantitative valuations was added to the survey. These valuations were the dividend discount model, the free cash flow to firm model and the free cash flow to equity model. The arithmetic mean of these three valuations was also included. Because of the time limit, and because quantitative valuation methods require a more effortful analysis, it was uncertain if students would be motivated to use these methods. As such, the valuations as well as the data required to calculate the valuations were provided to students. According to the feedback provided, these valuations typically constitute the first step in calculating fundamental value and would thus be needed for participants to provide an ecologically valid estimate of fundamental value.

While the large pool of information might be expected to dilute the impact of the anchor, Chapman and Johnson (1999) found that information-rich settings increased rather than decreased the anchoring effect, as participants had a larger pool of information from which to find evidence confirming their hypotheses.

After reading through the information docket, participants were presented with the following question: *What is your best estimate of AB Foods's intrinsic value?* Once the question was completed, participants could turn to the next page where they answered a question on the perceived effect of the share chart on their judgement. After answering these questions, participants were thanked for their participation and debriefed about the research. They were also presented with an e-mail address to which they could direct any questions or concerns.

The questionnaires from the student sample were collected after fifteen minutes.

3.5 Hypotheses

The research investigated one primary hypothesis and two secondary hypotheses. The primary research hypothesis states that participants in the high anchor condition will invest more money in the share than participants in the low anchor condition, while the null hypothesis states that the mean investment for the two conditions are equal. Formally:

$$H_0 : \mu_{high} = \mu_{low}$$

$$H_1 : \mu_{high} > \mu_{low}$$

This is the primary hypothesis for most research on anchoring and adjustment: That estimates are assimilated to the anchor, and thus that high anchors lead to higher

judgements and low anchors to lower judgements (for a summary, see Chapman and Johnson, 2002). The hypothesis is one-sided because the anchoring effect specifies that low anchor group will have lower valuations than the high anchor group. If the research hypothesis is supported, it will confirm the findings of Mussweiler and Schneller (2003) and show that stock market investment decisions are significantly affected by anchors in the investment environment. The research hypothesis will be rejected if there is no significant difference in the sample means. The pervasiveness of anchoring and adjustment leads the present study to expect the research hypothesis to be confirmed.

The first secondary research hypothesis states that the informativeness of the anchor will be positively related to the magnitude of the anchoring effect. Participants who consider the anchor informative are thus more likely to provide answers assimilated to it. While this might be considered self-evident, no anchoring research in the investment environment has tested the relationship between the informativeness of the anchor and the magnitude of the anchoring effect. If ρ is defined as the correlation between the informativeness of the anchor and the magnitude of the anchoring effect, the hypotheses can be defined as:

$$H_0 : \rho = 0$$

$$H_1 : \rho > 0$$

The final hypothesis states that participants who did not find the anchor informative will show a significant anchoring effect. This is to say that participants in the high condition who rated the anchor as uninformative will have a higher mean than participants in the low condition who did not find the anchor informative. Formally:

$$H_0 : \mu_{high|uninformative} = \mu_{low|uninformative}$$

$$H_1 : \mu_{high|uninformative} > \mu_{low|uninformative}$$

As with the primary hypothesis, it is important to note that the hypothesis is one-sided.

A statistically significant difference in means between participants in the two conditions when the anchor was rated as uninformative would be indicative of an anchoring process affecting investor decision making. This would be in line with the research by Northcraft and Neale (1987) who found that participants still showed an anchoring effect, even when the anchor was rated as irrelevant. It should be noted, however, that this hypothesis does not state that participants who consider the anchor unimportant will show an equal bias to those who consider the anchor important, it simply states that they will show some anchoring bias.

3.6 Data analysis

The first step of the data analysis was the removal of significant outliers. Due to the open-

ended nature of questions on anchoring and adjustment significant outliers regularly occur. As a result, many anchoring studies include some procedure for removing outliers (for example, Mussweiler, 2002; Oppenheimer, LeBoeuf & Brewer, 2007; Simonson & Drolet, 2004). The Grubbs' test (Grubbs, 1969) was used to detect outliers. Because the Grubbs' test is iterative, it prevented highly influential outliers from hiding less significant outliers.

The difference between the means of the high and low anchor samples was tested using an unpaired, one-sided two-sample *t*-test (Keller, 2009). In order to see if an equal variances *t*-test could be used, an *F*-test was conducted on the ratio of the two variances. Further tests were conducted to ensure that the assumptions of the *t*-test were not violated. Specifically, a normal quantile plot was drawn and a Kolmogorov-Smirnov test conducted to test the normality of the samples (Muchengetwa, 2010). The assumption of independence was not tested as there was no reason to suspect that the answers provided by different individuals would not be independent. The same tests were run on the data provided by participants who rated the anchor as uninformative.

In order to test for the correlation between the magnitude of the anchoring effect and the informativeness of the anchor, participants' valuations were normalised. The absolute value of the normalised valuations was then used to determine the magnitude of the anchoring effect. Because informativeness is an ordinal variable while the magnitude of the anchoring effect is a continuous variable, Spearman's rank correlation (a non-parametric test) was used to determine the correlation between the variables (Lehman, 2005).

3.7 Threats to validity

Research validity can be divided into two forms of validity: internal validity and external validity. Internal validity is the degree to which the experiment tests the research hypotheses (Bordens & Abbott, 2011). Any factor which undermines the research's ability to test its hypotheses is considered a threat to the internal validity. External validity refers to the degree to which the results of an experiment can be generalised beyond the experimental setting (Campbell & Stanley, 1963). Results which hold true in an experimental setting but fail to do so outside of the laboratory have a low external validity. In most experiments, researchers must find a compromise between internal and external validity (Gravetter & Forzano, 2008)—the more controlled an experiment is, the higher its internal validity but the lower the external validity. Alternatively, experiments conducted in real world situations are often high in external validity but low in internal validity.

3.7.1 Threats to internal validity

Campbell and Stanley (1963) identified seven general threats to internal validity: History, maturation, testing effects, instrumentation, statistical regression, selection biases and

experimental mortality. The following section will briefly discuss the relevance of these threats to the present study.

History effects occur when an unrelated event between two measurements affects the results (Campbell & Stanley, 1963). In a within-subjects research design where the same participant takes part in multiple different tests, this can be problematic. However, since a between-subjects research design was used for the present study, history effects were not considered a threat to validity.

Maturation refers to any change within participants due to the passage of time (for example, participants growing older or more tired; Campbell & Stanley, 1963). Experimental mortality is an extreme form of maturation where there is a difference in the number of participants that are lost from each condition over time. Since the duration of the present study is limited to fifteen minutes, and participants in both groups share these conditions, neither of these threats are expected to affect the results.

A testing effect is a “possible change in performance caused by participation in a previous treatment” (Gravetter & Forzano, p184, 2008). Although there were no previous treatments in the present study, it is possible that the questions on heuristics in the first section of the questionnaire made participants aware of the threat of biases and thus less likely to show an anchoring effect in the second section of the questionnaire. Testing effects are not considered to be a significant threat to the present study, however, as anchoring has proven to be remarkably robust. In a study by Wilson et al. (1996), participants had the anchoring effect explained to them and were informed of the presence of the anchor but continued to show a strong anchoring effect. As such, it is not believed that the mere mention of heuristics and biases would debias the anchoring effect.

In instrumentation, changes that occur to the testing instrument or the calibration of the testing instrument between measurements provide an alternative explanation for the results (Campbell & Stanley, 1963). This was not expected to be a problem in the present study since the measurements took place at the same time.

Statistical regression occurs when participants with extreme scores are selected for an experimental group (for example, students who perform poorly on an academic test; Bordens & Abbott, 2011). If these scores are coincidental rather than the result of an underlying difference, the extreme score group’s second measurement should return to the mean regardless of any intervention. Similar to the previous concerns, statistical regression was not considered a threat to the current design.

Finally, the biased selection of participants is a threat to internal validity that occurs when participants in one condition are selected in such a way that they systematically differ from participants in another condition (Campbell & Stanley, 1963). In the present study the same group of students were used for both conditions. In order to ensure that no differences between these students affected the results questionnaires were handed out in alternating order. By doing this, the threat of biased selection was minimised.

One threat to internal validity specific to the present study concerns the research instrument that was used. In the questionnaire participants received, the information needed to provide an estimate of fundamental value was included along with four fair value estimates. If these fair value estimates acted as alternative anchors (Whyte & Sebenius, 1997), they could distort the anchoring effect and thus make the dependent variable less reliable. With this threat in mind, the fair value estimates were included for two reasons: First, the stock decisions made by professional investors are almost always made when fair value estimates are available and visible to the decision maker. As such, the inclusion of fair value estimates was considered important for the external validity of the research. Second, the experiment had limited time available and it was decided that participants' time would be better spent considering the available information rather than calculating fair value estimates.

3.7.2 Threats to external validity

As with threats to internal validity, the present study faces some threats to external validity. The aim of the study was to investigate if anchors would affect stock market decisions. However, due to difficulties in obtaining a significant sample of professional investors, a sample of finance students was used. As Campbell and Stanley (1963) highlight, it is logically impossible to generalise findings from a very specific sample to a broader population in any situation. However, by relying on laws that are identified by the researchers, generalisation can be attempted. In the present study, the literature review showed that experts should display an anchoring effect similar to that of non-experts (for example, Englich et al., 2006). As such, it is believed that the results can reasonably be generalised to an expert population. However, due to the difference between the sample and the target population the sample will always be a threat to external validity.

A second threat to external validity concerns the lack of incentives. While the literature suggests that incentives have little to no effect on the anchoring bias (Simmons, LeBoeuf & Nelson, 2010), it should be noted that the incentives present in stock market decisions are of a different magnitude than those typically offered in experiments. It is precisely for this reason that incentives could not be offered in the present study. Small financial (and non-financial) incentives are ineffective (see, for example, Wilson et al., 1996), while the

incentives present in every day stock market decisions cannot be matched in an experimental setting. However, due to the pre-existing literature on incentives and anchoring, the lack of incentives is not considered to be a significant threat to validity.

3.8 Ethical considerations

In order to obtain a student sample, a full research proposal was submitted to the University of Cape Town's Commerce Faculty Ethics in Research Committee. The research proposal was approved by the committee. Furthermore, the university's Director of Student Affairs gave approval for the use of students in the sample.

Participation in the study was entirely voluntary and participants were free to withdraw from the study at any time. The questionnaire was also anonymous and there was no risk of psychological harm being caused by the questionnaire. As such, a consent form was not necessary according to the APA Ethical Principles (*section 8.05*; American Psychological Association, 2010).

Although participants were not explicitly told which cognitive bias the study examined, they were informed that the purpose of the study was to examine the effect of cognitive biases on stock market investing. It was felt that deception regarding the broad purpose of the study was unnecessary as multiple studies have shown that the effects of anchoring and adjustment remain unchanged even when participants are aware of the purpose of the research (Epley & Gilovich, 2005; Wilson et al., 1996). As such, the ethical guidelines regarding deception are not relevant to the study.

4. Data analysis

4.1 Introduction

The present research paper sets out to answer one question: Does the anchoring and adjustment heuristic affect the investment decisions made by stock market investors? In order to answer this question, it is important to show not only that participants are affected by anchors but also that they do not consider these anchors informative. As such, a secondary research question was asked: Are stock market investors affected by anchors even when they consider them uninformative? To answer these questions, the research method used by Mussweiler and Schneller (2003) was modified to include a measure of the informativeness of the anchor. Furthermore, the information presented to participants was more closely aligned with the information used in everyday investment decisions. These changes will allow the present study to answer its research question more accurately.

The findings will be separated into three subsections in order to present the complex results

from the present study in an intelligible fashion. The first section will introduce the sample and describe the treatment of the data. In the second subsection, the data will be analysed as a whole and after being grouped into distinct subsets. By analysing the full data set, the effect of the anchor on the share valuations can be analysed, while subdividing the data set will allow more specific questions regarding the anchoring effect to be answered. The section will be concluded with a brief analysis of the questionnaire's introductory questions on the importance and prevalence of information on behavioural economics.

4.2 Sample

Two hundred and ninety-five students from the University of Cape Town's faculty of commerce participated in the survey. All students were undergraduates completing their fourth and final year of finance or actuarial science degrees. Two hundred and thirty-eight students from the *Applied Investments* (FTX4056F) course completed the questionnaire while fifty-seven students from the *Actuarial Science III: Financial Economics* (BUS4028F) course completed the questionnaire. This was approximately all attending students in both classes. All students had completed multiple courses on equity valuation and were expected to be comfortable with the quantitative valuation models used in the questionnaire.

Before the data could be analysed, the data were entered into a spreadsheet and imported into the JMP statistical analysis software. Any questionnaires with unclear or illegible answers were entered at a later date by an assistant with no knowledge of the hypotheses. All two hundred and ninety-five participants completed the questions relating to the importance and prevalence of information on behavioural economics. Twenty participants failed to answer the share valuation question and were excluded from the primary research question's data set. An additional three participants were excluded from the data set concerning the informativeness of the anchor as they failed to complete the question measuring the informativeness of the anchor.

Once the data were entered, outliers were identified and excluded. Most research on anchoring and adjustment has used a sigma approach to identify outliers, with values that differ from the mean by more than two (Englich & Soder, 2009; Mussweiler & Epstude, 2009), two and a half (Kassam et al., 2009; Kaustia et al., 2008), three (Englich & Mussweiler, 2006; Mussweiler & Englich, 2005) or three and a half (Oppenheimer et al., 2007) standard deviations being excluded. This was not possible in the present study, as the value of a few extremely high outliers (67975.29, 10151.61, 5500, 2417.97) and one extremely low outlier (6) resulted in a distribution where only two values were more than one sigma away from the mean ($M = 840.32$). The four high outliers were removed after a visual inspection of the data.

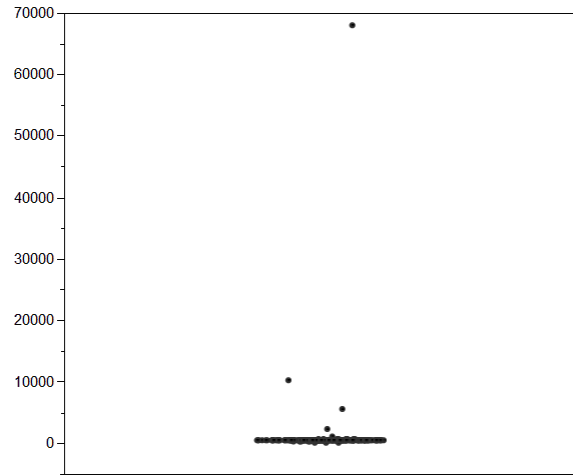


Figure 3: Significant outliers

An adaptation of the Grubbs' test, the generalised ESD test (NIST/SEMATECH, 2012), was used to identify further outliers. The Grubbs' test examines, at a given significance level, whether all the observations in a sample comes from the same population (Grubbs, 1969). This is tested by calculating the probability of the largest or smallest value in the sample coming from a different population than the rest of the sample. The test is run iteratively. Once an outlier is detected, it is removed from the sample and the test is repeated until no statistically significant outlier is detected. The generalised ESD test improves on the Grubbs' outliers test by adjusting the critical values appropriately for the number of outliers that are tested for (NIST/SEMATECH, 2012). For the generalised ESD test to accurately identify outliers the data must be approximately normally distributed. While the data for the present study were not normally distributed, it suggested approximate normality, providing justification for the use of the generalised ESD test. The generalised ESD test ($\alpha = 0.05$) identified ten low outliers (6, 36.81, 177.87, 215, 248, 300.23, 372.4, 385, 446, 448) and five high outliers (67975.29, 10151.65, 5500, 2417.97, 1000). The sixteenth value tested by the ESD test (615.86) was found to not be a significant outlier ($G = 2.877 < G_{0.05,275} \approx 3.695$).

A distribution-free method of identifying outliers confirmed the findings of the generalised ESD test. Tukey (1962, 1977) suggests creating a "fence" by multiplying the interquartile range by 1.5 and subtracting the resulting value from the first quartile while adding the resulting value to the third quartile. The probability of an observation falling outside of this range is 0.003 (Blakenship, Wegener, Petty, Detwiler-Bedell & Macy, 2008) and can thus be considered an outlier. Using Tukey's method, sixteen outliers were detected: The sixteen observations tested by the generalised ESD test. As the sixteenth observation (615.86) fell just outside the upper bound of the fence (615.785), and was not considered an outlier by the generalised ESD test, it was included in the data set. The other fifteen outliers were excluded.

4.3 Identifying the anchoring effect

In order to decide which test to run on the difference between two means, the normality of the sample had to be investigated. As the histogram shows, the data came from a roughly normal population. However, visual inspection of the histogram reveals a few significant deviations from a normal distribution. The data set is bimodal with an unexpected number of observations in the 520-530 and 580-590 ranges and a lack of observations in the ranges surrounding them. This abnormality is explained by participants defaulting to the quantitative valuations provided to them (522.81, 546.23, 552.10 and 587.27) for their estimate of the share's value. Seventy-three of the participants defaulted to one of the four valuations for their estimate. Out of the eighteen participants who provided an answer between 580 and 590, thirteen gave an answer of 587.27 and one gave an answer of 587. The quantitative valuations also explain the slight elevation in responses between 540 and 560 although this elevation is less apparent as it falls in the middle of the histogram. These deviations are clearly shown on the normal quantile plot as horizontal lines.

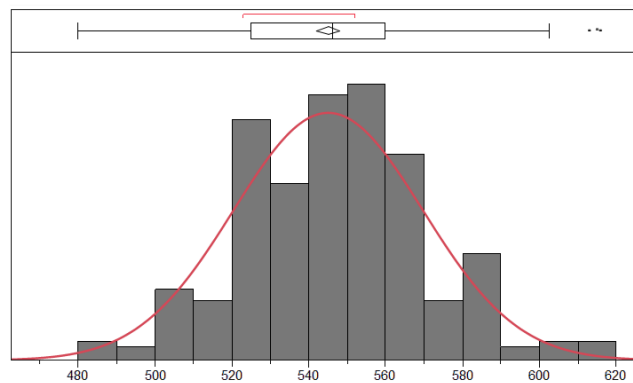


Figure 4: Histogram of the full sample with a normal distribution overlay

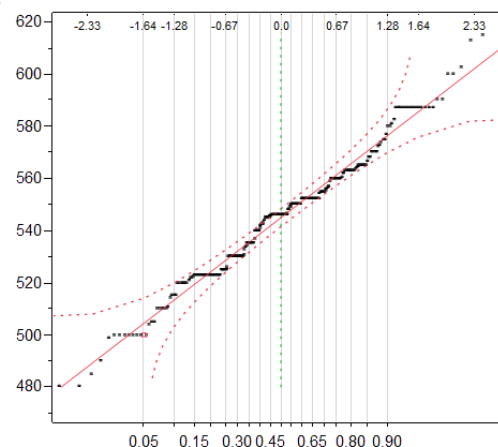


Figure 5: Normal quantile plot

The sample also has abnormally fat tails. While the histogram suggests that there are more

observations at the tails than expected, excess kurtosis is not significant at 0.183 (critical value = 0.531; Tabachnick & Fidell, 1996). When the outliers removed by the Grubb's test are included into the data set, the distribution is incredibly leptokurtic (excess kurtosis = 30.928). This could be a characteristic of share valuation which is exacerbated by the lack of direct investment experience of the sample. As is evident from stock market bubbles, investors' perception of value can often differ significantly from calculations of fundamental value (Williams, 2010) which could potentially explain why a few participants chose values considerably higher or lower than suggested by the valuations. This disparity between investors' valuation and quantitative valuations could increase if participants, who lack target specific knowledge and experience, have a highly dispersed probability distribution for answers (Mussweiler & Strack, 2000b).

A Shapiro-Wilk test (a goodness-of-fit test for normality) confirmed what the histogram suggested: It cannot be assumed that the observations come from a normal distribution ($p = 0.0133$). As such, a non-parametric test was used to test whether the values given in the high and low anchor samples differ significantly. Nonparametric tests are tests which do not require interval data and do not make use of parameters (Gravetter & Forzano, 2008). This is to say that a nonparametric test would not test if the means of two populations differed (since the means are parameters) but rather if the locations of the observations from the two populations differed. Importantly, nonparametric tests are also called distribution-free tests because they can be used when the distribution requirements of parametric tests are not satisfied (Keller, 2009). As such, a nonparametric test can be used to determine whether the high and low anchor conditions in the present study differ significantly even if the data are not normally distributed. This requires that the hypotheses are restated as follows:

H_0 : The population locations are the same

H_1 : The location of the high anchor population is to the right of the location of the low anchor population

The Wilcoxon rank sum test is the nonparametric test which should be used to compare two populations when the normality requirement necessary to perform a t -test is not met (Keller, 2009). The only requirement of the Wilcoxon rank sum test is that the observations are independent. Independence can be assumed in this study as valuations made by different participants who could not communicate cannot reasonably be expected to be related. In order to compare two non-normally distributed populations the Wilcoxon rank sum test ranks each value in the combined population from smallest to largest. The test statistic is the sum of either one of the two populations' ranks which is then compared with a critical value in order to determine statistical significance.

A one-sided Wilcoxon sum rank test found no significant evidence that the low anchor condition produced valuations lower than the high anchor condition ($p = 0.1607$). A p-value of 0.16 implies that the probability that low anchor group came from the same population as the high anchor group is 16%, a value not low enough to conclude that an anchoring effect occurred. As such, there is not enough evidence to state that anchors in the stock market environment result in an anchoring bias. The primary null hypothesis could thus not be rejected.

In order to test if a specific segment of the population showed an anchoring bias, the population was subdivided into the courses the students were obtained from. It is possible that students from the finance course used different methods to reach their valuations than students from the actuarial science course, resulting in an anchoring effect in one population but not in the other. Observations from the finance class ($n = 212$) were not normally distributed ($p = 0.0298$) and, as such, the sample was tested using a one-sided Wilcoxon sum rank test. No significant difference between the low anchor and high anchor condition was found in the finance class with the result mirroring that of the full sample ($p = 0.1707$). Visual inspection suggested that the actuarial science class ($n = 49$) was normally distributed and this was confirmed with a goodness-of-fit test ($p = 0.2556$). An F -test for the equality of variances was performed and no evidence of unequal variances was found ($s_{low} = 24.580$; $s_{high} = 25.861$; $p = 0.8149$). As such, the variance of the high and low anchor conditions could be pooled. A pooled variance t -test showed no anchoring effect in the actuarial science class ($\bar{x}_{low} = 549.634$; $\bar{x}_{high} = 550.492$; $p = 0.4531$). The similarity between the two conditions can clearly be seen in *Figure 4*.

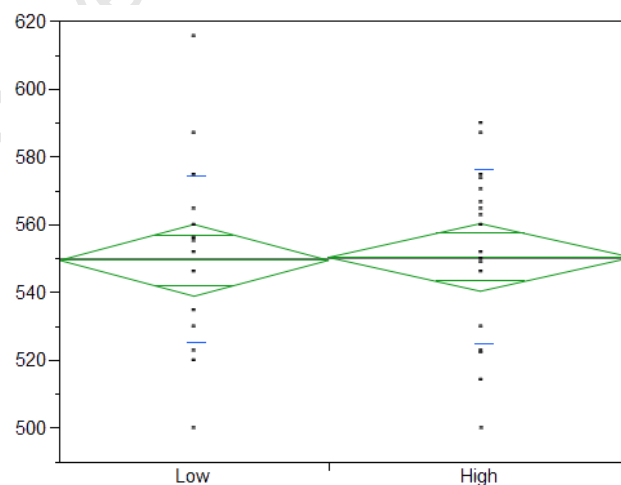


Figure 6: Comparison of means in the actuarial science class

In order to test if the informativeness of the anchor affected the anchoring bias, responses were divided into three groups based on their answer to the question on the informativeness

of the anchor: Uninformative (participants who responded “Not at all”; $n = 61$), slightly informative (participants who responded “Slightly”; $n = 98$), and informative (participants who responded “Moderately” and “Significantly”; $n = 100$). Two participants who provided a share valuation but did not answer the question on the informativeness of the anchor were excluded from the analysis.

While an analysis of the distributions found no significant evidence that the populations were not normally distributed ($p = 0.0782$, $p = 0.1857$ and $p = 0.2400$ respectively), the low p -value for the uninformative group, combined with a visual inspection of the histogram suggested that the uninformative group might not be normally distributed. As such both a t -test and a Wilcoxon sum rank test were performed on this data set. F -tests of unequal variances found no significant difference between the high and low anchor conditions of any of the populations ($p = 0.7531$, $p = 0.8861$ and $p = 0.3589$ respectively).

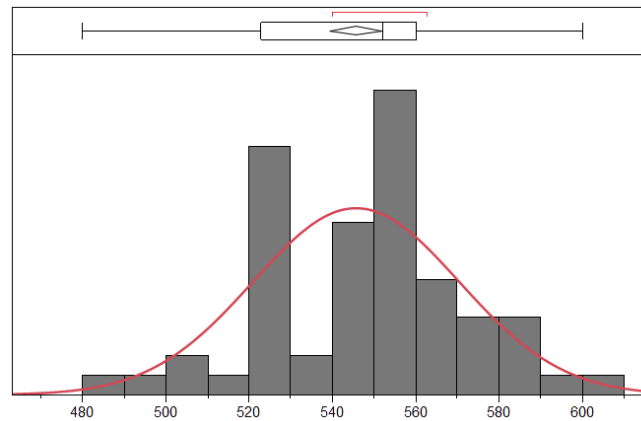


Figure 7: Histogram of the uninformative anchor sample with a normal distribution overlay

In the uninformative anchor group, no anchoring effect was found with either the pooled variance t -test ($\bar{x}_{low} = 545.679$; $\bar{x}_{high} = 546.114$; $t = 0.070$; $p = 0.4722$) or the Wilcoxon sum rank test ($z = 0.229$; $p = 0.4096$). This is to say that when participants did not consider the past share price a relevant source of information there was no difference between the low and high anchor conditions. The same result was obtained in the slightly informative anchor group with a pooled variance t -test finding no evidence of an anchoring effect ($\bar{x}_{low} = 545.392$; $\bar{x}_{high} = 545.956$; $t = 0.114$; $p = 0.4546$). In both these groups, the difference between the mean of the low and high anchor conditions was roughly 0.5c. This is to say that the share’s value differed by only 0.092% when participants did not consider the anchor relevant. There is thus not enough evidence to reject the second secondary null-hypothesis. In the informative anchor group, a difference was found between the means of the low and high anchor conditions. A one-sided pooled variance t -test resulted in a p -value of 0.0681 ($\bar{x}_{low} = 539.898$; $\bar{x}_{high} = 547.450$; $t = 1.502$) suggesting that participants who

found the anchor informative provided answers closer to the anchor. Together with the evidence that has been presented so far, this strongly suggests that no subconscious anchoring effect occurred in the present experiment. Rather, any difference that exists between the low and high anchor conditions can be explained by the conscious use of the anchor.

Spearman's rank correlation found no correlation between the magnitude of the anchoring effect and the informativeness of the anchor ($\rho = 0.014$, $p = 0.828$). Since no anchoring effect was detected, this was the expected result. This result held true when the high and low anchor groups were tested individually ($\rho = -0.041$ and $\rho = 0.0845$ respectively). Neither of these correlations were statistically significant ($p = 0.643$ and $p = 0.341$ respectively)

The third and final way that the data were grouped was into participants who gave one of the four experimenter-provided valuations ($n = 83$) and participants who did not give one of these valuations ($n = 178$). For simplicity, these groups will be respectively referred to as the unmodified and modified groups. The unmodified group includes participants who gave the exact value provided by one of the quantitative valuation techniques ($n = 75$) as well as any of these valuations rounded upwards or downwards to the nearest cent ($n = 8$). If these groups show different levels of anchoring it might highlight what kind of investment decision making results in an anchoring effect.

Because the unmodified group's observations consisted of only four valuations the data were not normally distributed ($p < 0.0001$). A Wilcoxon rank sum test showed a highly significant anchoring effect ($z = -2.190$; $p = 0.0143$). As *Figure 6* shows, the low anchor condition has more valuations of 522.81 than the high anchor condition ($n = 16$ compared with $n = 10$) and fewer valuations of 587.27 ($n = 3$ compared with $n = 11$).

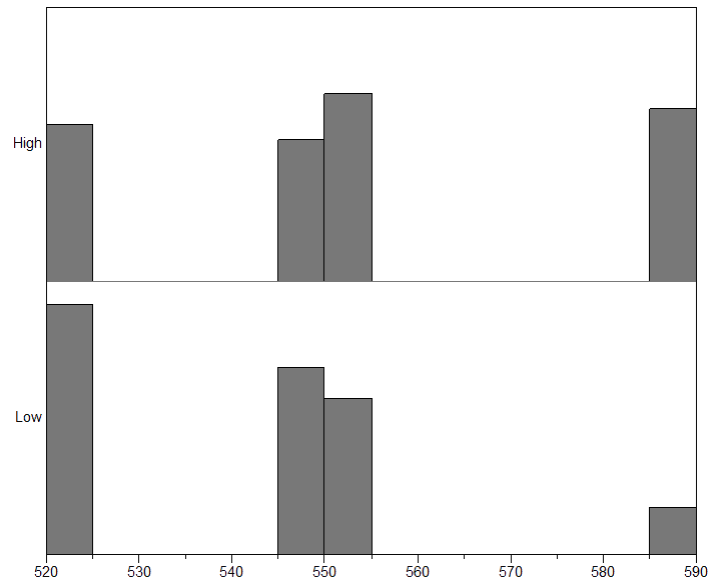


Figure 8: Comparative histograms of the low and high anchor conditions

In contrast with the unmodified group, no anchoring effect was found in the modified group. Visual inspection of the histogram (Figure 7) suggested approximate normality but this was contradicted by a Shapiro-Wilk W test ($p = 0.0449$). As such, both a Wilcoxon sum rank test and an equal variances t-test were run. Neither test found an anchoring effect ($p = 0.3911$ and $p = 0.5857$).

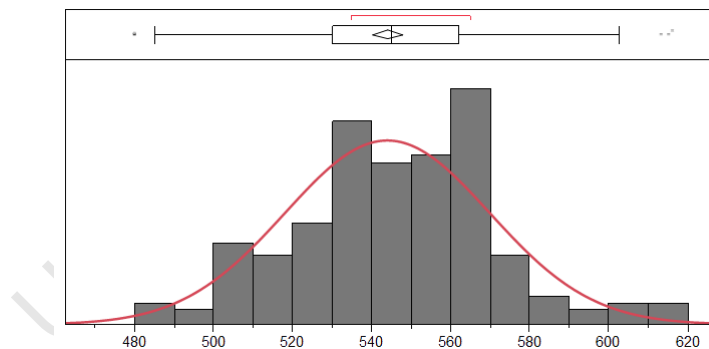


Figure 9: Histogram of the modified sample with a normal distribution overlay

4.4 Auxiliary questions

Participants were asked four auxiliary questions concerning the importance and prevalence of education on behavioural economics at the start of each questionnaire. While these questions were not related to the hypotheses, they offer an interesting perspective of students' perception on behavioural biases and are worth examining.

The first question asked was "How much do you believe investment decisions are affected by psychological biases?" with answers ranging from "1. Not at all" to "4. Significantly." As the bar graph shows, no participants said "Not at all" and only twenty-eight participants said

“Slightly.” In contrast, one hundred and twenty-nine participants said psychological biases moderately affect investment decisions while one hundred and thirty-eight participants said psychological biases significantly affect investment decisions. As such, more than 90% of participants (267 out of 295) believed that psychological biases have a strong effect on investment decision making.

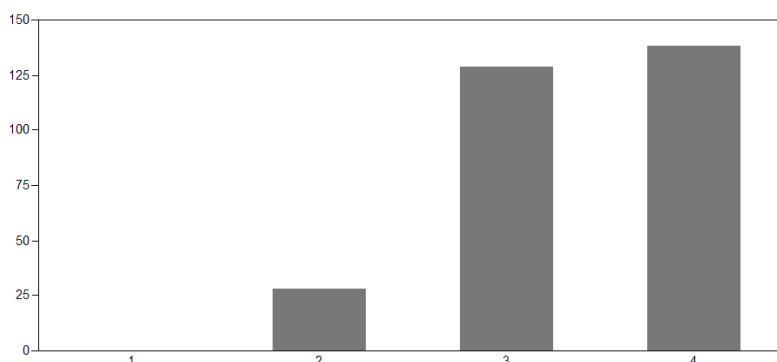


Figure 10: Bar graph measuring the perceived influence of behavioural biases

In the second question, participants were asked how informed they believed the typical investment analyst was regarding psychological biases in the investment context. The answers ranged from “1. Uninformed” to “4. Well informed.” For this question, most participants judged that investment analysts were either “Mostly uninformed” or “Somewhat informed” with only 7% of participants considering analysts “Uninformed” or “Well informed.”

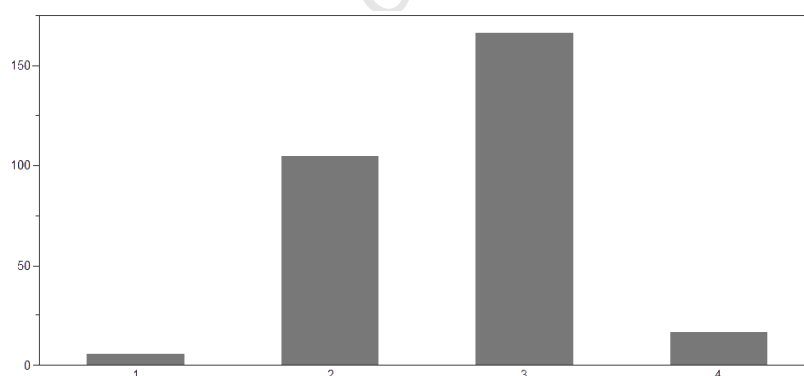


Figure 11: Bar graph measuring perceived knowledge of analysts regarding behavioural biases

The third question asked participants how important information on psychological biases was to them. Answers ranged from “1. Not important” to “4. Very important.” As can be seen in *Figure 10*, most participants considered information on investment biases to be either very important or moderately important to them. Less than 10% of participants considered information on investment biases unimportant.

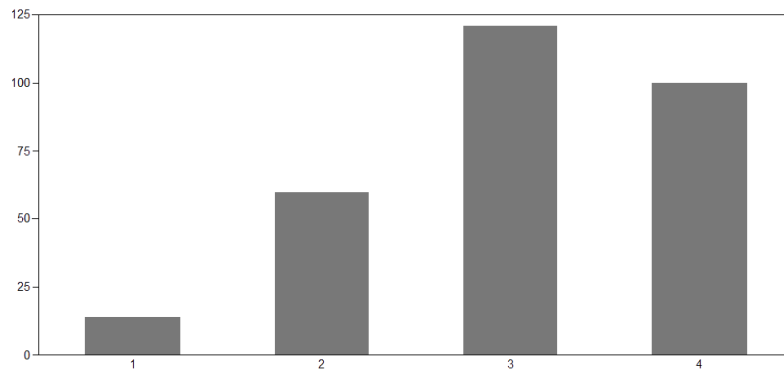


Figure 12: Bar graph measuring the importance of information on psychological biases.

The final question asked if participants believed investment analysts were provided with enough information regarding behavioural biases, to which they could answer “1. No” or “2. Yes.” Two hundred and thirty-five participants said “No” while sixty participants said “Yes.”

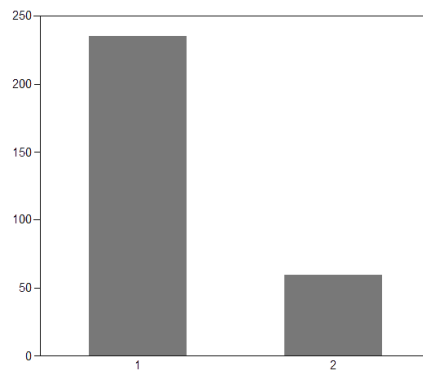


Figure 13: Bar graph measuring whether enough information on psychological biases is provided to analysts

Together, these results strongly suggest that students consider research on behavioural economics important to financial decision makers and that not enough information on behavioural economics is provided to students.

5. Discussion of findings

5.1 Introduction

The conducted survey shows that stock charts are unlikely to bias investment decisions when presented together with a comprehensive analysis of the firm. An analysis of the data set did not find enough evidence, over the entire sample, to suggest a systematic difference between investors presented with a stock chart that included a salient peak and investors presented with a stock chart that included a salient trough. This is not to say that an anchoring effect cannot or does not exist in investors, but rather that a stock chart, when presented together with comprehensive quantitative information, is insufficient to result in an

anchoring effect.

It was further shown that investors may consciously use stock charts to assist in share valuations. When extended to other research on anchoring and adjustment, this finding highlights the importance of including a measure of the informativeness of the anchor. Even anchors which are normatively uninformative may be relied on by participants for information. The lack of such a measure is a serious shortcoming of most research on anchoring and adjustment, both in the investment environment and in general. Without a measure of the informativeness of the anchor, it remains unclear whether participants in anchoring and adjustment studies show an anchoring effect, base their judgement on conversational inferences (Grice, 1975), or consider the anchor informative and its use rational.

The following section will interpret the aforementioned results in terms of the literature discussed. Specific emphasis will be placed on explaining the lack of an anchoring effect when past research strongly suggests that an anchoring effect would occur.

5.2 Anchoring process

The most significant finding of the present survey was that no anchoring effect occurred. This result is in stark contrast with studies showing the general robustness and durability of anchoring (e.g. Ariely et al., 2003; Chapman & Johnson, 1994; Mussweiler, 2001; Wilson et al., 1996) and specifically with studies showing significant anchoring effects in the stock market environment (e.g. Kaustia et al., 2009; Mussweiler & Schneller, 2003). In order to explain the anomalous finding, four aspects of the research will be focused on and it will be shown how each aspect contributed to the overall results. These aspects are the informativeness of the anchor, decreased uncertainty, multiple anchors and elaboration.

5.2.1 Informativeness of the anchor

The strong correlation found between the informativeness of the anchor and the magnitude of the anchoring effect, combined with the lack of a measure of informativeness in most anchoring studies, suggests that the magnitude of the anchoring effect may often be explained by the conscious use of the anchor by research participants. This is especially true when the anchor is theoretically uninformative but realistic (such as a house's listing price or a share's past price; Northcraft & Neale, 1987; Mussweiler & Schneller, 2003). With such anchors, participants might not be aware of the normative theory, or they may only partially agree with the theory, resulting in the conscious use of the anchor.

However, the present study's results cannot be explained solely by the informativeness of the anchor. For one, if we assume the anchoring effect found by Mussweiler and Schneller

(2003) is purely the result of the anchor being consciously used it would necessarily imply that almost all participants found the anchor to be either moderately or significantly informative. There is no evidence to suggest that this would be the case. The present study used a student sample similar to the sample used by Mussweiler and Schneller, and only 38% of students considered the anchor moderately or significantly informative. Furthermore, the informativeness theory fails to explain why no anchoring effect occurred when participants considered the anchor uninformative. As far back as Tversky and Kahneman's (1974) wheel of fortune, there has been evidence that anchors which participants consider uninformative exert a powerful effect on subsequent judgements and this finding has only been reinforced in recent years (e.g. Chapman & Johnson, 1999; Mussweiler & Strack, 2000b; Simonson & Drolet, 2004).

As a result, the informativeness of the anchor explains the magnitude of the anchoring effect in some studies on anchoring and adjustment but it fails to explain the lack of an anchoring effect in the present study.

5.2.2 Decreased uncertainty

One of the preconditions for anchoring to occur is uncertainty (Tversky & Kahneman, 1974). When participants know or have a way to calculate the answer, heuristic use is unlikely to occur (Strack & Mussweiler, 1997). As significant quantitative data were provided to participants, including three commonly used valuations, it is possible that participants in this study relied on this information and their knowledge of share valuation methods to obtain an 'objective' valuation, thus nullifying the anchors. It should be noted that it is not important whether the firm's fundamental value was uncertain, but rather whether participants were uncertain about the answer. Participants who followed simple rules such as "DDM provides the most accurate share valuations" would have had a certain answer even if the firm's actual value was uncertain. It should further be noted that the presence of the quantitative valuations would not be enough, on its own, to mitigate the anchoring effect as participants who need to choose between four valuations would still be influenced by selective accessibility anchoring. Instead, the presence of both valuations and simplifying rules would be needed.

While this theory explains the lack of an anchoring effect, it is contradicted by the results from the modified and unmodified valuation groups. Participants whose estimate of share value were unmodified from the quantitative valuations provided to them should, according to the theory of decreased uncertainty, have shown the smallest anchoring effect as they were the participants most likely to have relied on their knowledge of valuation methods to make a decision. Participants in the modified group who chose values not provided to them

should have felt more uncertainty and thus showed a larger anchoring effect. An analysis of the data found the opposite result with participants from the unmodified group displaying a significant anchoring effect ($p = 0.0143$) while participants from the modified group displayed no anchoring effect ($p = 0.5857$). As such, it is unlikely that the lack of an anchoring effect was caused by decreased uncertainty.

5.2.3 Multiple anchors

The present study's most significant deviation from the experiment conducted by Mussweiler and Schneller (2003) is the inclusion of quantitative valuations in the research materials. These valuations were included in order to align the information provided to participants more closely with the information analysts use to determine fundamental value. These values also have the potential of serving as anchors. Since only one of the anchors (the peak or trough on the stock chart) was manipulated to differ between the conditions and the other anchors were held constant, an anchoring effect was expected. However, as suggested by Whyte and Sebenius (1997), if the quantitative valuations acted as salient comparison standards they could have diminished the anchoring effect by decreasing the chance of the manipulated anchor being used, diluting the effect of the manipulated anchor and resulting in information inconsistent with the manipulated anchor being activated.

Since there were multiple quantitative valuations, anchors inconsistent with both the manipulated trough and peak on the stock chart were present. Furthermore, and in contrast with the research on multiple anchors, these anchors were more intuitive comparison standards than the trough or peak on the stock chart. As a result, it is likely that the process Whyte and Sebenius (1997) suggested whereby the anchoring effect is diminished through dilution and contradictory anchoring information completely mitigated the anchoring bias. As the investment environment is filled with anchors, these findings suggest that any anchoring effect would be diminished in many investment situations.

The results can further be interpreted based on research by Ariely et al. (2003). According to Ariely and colleagues, people show coherent arbitrariness: People coherently interpret information around an arbitrary starting point. The starting point is determined by the first anchor participants use, while each subsequent anchor is coherently interpreted based on this starting point. As such, the initial anchor is significantly more impactful than subsequent anchors. While the manipulated anchor was presented first in the present study, it was not necessarily as intuitive a comparison standard as the current stock price or the quantitative valuations and as such may not have been used immediately. Even though non-initial anchors still result in an anchoring effect (Ariely et al., 2003), this effect is small and, given the variance of the dependent variable and the variety of potential initial anchors, might not

be detectable.

It should further be noted that, by manipulating the stock chart to include a peak or a trough, another anchor with implications contrary to the manipulated anchors was created. De Bondt (1993) found that non-expert investors often rely on price trends, which they expect to continue. By creating stock charts with an equal closing price, the peak on the price chart necessarily resulted in a downwards trend toward the current price, while the trough resulted in an upwards trend. Students who noticed these trends along with the manipulated anchor would have inadvertently used the consider-the-opposite technique, mitigating some of the anchoring effect (Mussweiler et al., 2000). Mussweiler and Schneller (2003) found the assimilative effects of the price peak and trough to be stronger than those of the trend, but in the present study, where the price peak and trough was not necessarily the initial anchor, this might not be true.

The presence of multiple anchors best explains the lack of an anchoring effect in the present study. As Mussweiler and Schneller (2003) did not include quantitative valuations (which are natural comparison standards) it also explains the results differing between these studies, and while the anchoring effect found in the unmodified group cannot be explained by the theory of multiple anchors, the unmodified group's results do not contradict the theory either.

5.2.4 Elaboration

An intuitive explanation of the modified and unmodified results is that participants who modified the valuations engaged in a more thorough analysis of the information and thus relied less on heuristics (Edwards & Weary, 1993). While elaboration results in a smaller bias for most heuristics, it is generally not true with anchoring and adjustment. In fact, Chapman and Johnson (1999) found that increased elaboration resulted in a larger anchoring bias, and this was confirmed by Bodenhausen, Gabriel and Lineberger (2000) and Epley and Gilovich (2005). Epley and Gilovich's (2005) research mentions an important caveat, however: If elaboration and effortful thought is "systematically different in both its content and implications" (p. 202), it would reduce the anchoring effect by activating anchor inconsistent information. As the researchers point out, this typically does not occur. However, there are multiple plausible comparison standards in the present study. Participants who engage in more effortful thought are more likely to test these valuations as possible answers, and since there are both high and low valuations, participants who analyse the valuations will activate information consistent and inconsistent with the provided anchors, resulting in a balanced knowledge pool. In contrast, participants in the unmodified group are likely to engage in less effortful thinking. For these participants, the anchor creates a biased knowledge base which affects the valuation method chosen and, since participants

rely purely on the valuation method to value the firm, the anchor affects participants' estimates of fundamental value.

The data thus suggest that a significant number of participants in the unmodified group relied on a biased knowledge pool to choose a valuation method without considering the other valuations in greater depth. However, as with other experiments on the anchoring effect, it is impossible to state that all participants in one condition used a specific cognitive process. While this theory therefore provides a convincing explanation for the difference between the modified and unmodified groups, more research on the cognitive processes used to reach modified and unmodified valuations is needed.

5.3 Findings for investors

Research on anchoring and adjustment suggests that professional investors might be specifically vulnerable to the anchoring bias. Anchoring is unaffected by general expertise or by the richness of information available (Englich & Mussweiler, 2001; Mussweiler & Strack, 2000b; Northcraft & Neale, 1987), so investors high in expertise who make decisions in an information-rich environment are unlikely to show a diminished anchoring effect. The anchoring bias is more pronounced in situations of high emotion (Araña & León, 2008; Kassam et al., 2009) and occurs when decisions are uncertain (Chapman & Johnson, 2002). Since investment decisions are inherently uncertain (Shiller, 1999), and often has the potential for substantial financial loss, investment decisions should be vulnerable to the anchoring bias.

What the present study shows is that the situation might not be as dire for investors as expected. Over the full sample, no significant anchoring effect was found and the means of the low and high anchor conditions differed by only 0.58%. Since the coefficient of variation is 4.52%, it can be seen that the difference between the two conditions is not only statistically non-significant, it is also incredibly small when compared with the variance present in any share valuation. It is thus clear that the high and low anchor had no practical effect on participants' investment decisions.

Of specific import to investors is that effortful thought and increased elaboration decreased the anchoring effect. This contradicts earlier findings on the correlation between anchoring and adjustment and effortful thought (e.g. Epley & Gilovich, 2005). For investors, it means that the anchoring bias can be mitigated, or even removed, by considering all the information available on a firm. Since a thorough analysis of a firm is likely to generate multiple anchors, an analysis of this information should result in an unbiased pool of activated information.

Further good news for investors is that the anchoring effect in other studies on anchoring and adjustment in the research environment (e.g. Marsat & Williams, 2010; Mussweiler &

Schneller, 2003) might be overstated. A significant difference between the high and low anchor was detected in the present experiment when participants made conscious use of the anchor. However, this effect clearly differs from the unconscious anchoring effect since it can be controlled by participants. As other studies in the field did not include a measure of informativeness, how much of the difference between the conditions was caused by an anchoring effect and how much was caused by the conscious use of the anchor should be questioned. This is not to say that other studies did not show any anchoring effect but rather that the effect might be weaker than stated.

The present study also provided participants with more comprehensive information than in many studies on the anchoring effect in an investment environment (for example, Anderson & Settle, 1996; Kaustia et al., 2008), and based on the feedback from the pilot study, with information more useful to investors than other experiments (e.g. Mussweiler & Schneller, 2003). As a result, the information provided to participants is most similar to the information used in real world decision making. The fact that no anchoring effect occurred when realistic information was used is heartening for investors.

Perhaps the most encouraging finding for both investors and decision makers in general is that the anchoring effect can be debiased automatically in certain situations. No specific effort was made to debias the anchoring effect in the present study, yet participants did so automatically by considering all the information at hand. If this finding can be replicated, it would suggest that the anchoring bias is less robust outside of the experimental setting than previously believed.

While undoubtedly positive for investors, these findings do not show that the anchoring bias does not affect investors. The results from the unmodified group reinforces past research that investors are affected by anchoring and adjustment (Kaustia et al., 2008; Marsat & Williams, 2010; Mussweiler & Schneller, 2003). Instead, these findings show that investors who engage in careful analysis of the data when multiple anchors are available debias the anchoring effect. This leaves a large number of investors and investment situations vulnerable to bias. For one, not all investors make use of multiple different valuation methods (although research by Grivillers, 2007, suggests that expert investors use 3.59 valuation techniques on average). Reliance on one valuation technique might create an anchoring bias, as the result from the valuation creates an anchor which biases participants' search procedure, resulting in participants activating more evidence in support of the valuation than is warranted. Similarly, a cursory examination of investment opportunities would still be affected by the anchoring bias. As a result, strong investment opportunities with low anchors might be screened out while poor investment opportunities with high anchors are considered for further research. There are thus many situations in which an

anchoring effect could still occur, while it is only when a detailed analysis is conducted and multiple contrasting salient comparison standards are present that an anchoring effect would not occur.

It is also unclear whether all anchoring effects in the investment environment would be debiased by the presence of multiple anchors or if this finding is restricted to the specific anchors present in the questionnaire. As Ariely and colleagues (2003) discovered, the first anchor encountered has a proportionally larger impact than any subsequently encountered anchors. The results from the present study were largely unaffected by this finding because the valuations were very significant comparison standards while the manipulated anchor was comparatively subtle. However, if the initial anchor is a more important comparison standard, such as the share's current price (Marsat & Williams, 2010), it is unclear if less significant comparison standards would still debias the anchoring effect.

A further concern for investors and investment analysts is that the anchor affected which valuation method participants chose (as evidenced by the unmodified group's results). When participants were provided with multiple valuation models, most participants did not show an anchoring effect. However, in many situations participants will not be presented with these models beforehand and will need to make a decision about the valuation method to use. In such situations, evidence from other studies in the field (such as Mussweiler and Schneller, 2003) suggests that participants would be significantly affected by the anchor, resulting in valuation techniques supporting the anchor being chosen.

Taken together, these findings paint a complex picture for investors. Anchoring can be debiased automatically in a situation with multiple contradictory anchors. This is not to say that anchoring does not take place; there is strong evidence to suggest that anchoring does take place in the investment environment but is debiased. However, the exact conditions required for debiasing to take place are unclear.

5.4 Limitations of the study

Although every effort was made to limit threats to validity and make the research as applicable as possible to investors, the study is not without limitations. As mentioned previously, the primary limitations of the present study are:

1. A sample of finance students was used rather than professional investors, limiting the external validity of the research.
2. Participants were provided with fair value estimates which potentially acted as additional anchors.
3. Participants were not incentivised to make accurate decisions.

Especially significant is the inclusion of fair value estimates. Future research should investigate whether an anchoring effect will occur when fair value estimates are excluded.

A further limitation of the study is the inability of the results to be compared with those of Mussweiler and Schneller (2003). Although the present study did not attempt to replicate the research method used by Mussweiler and Schneller, their research method was used as the basis for the current study. Three changes were made to Mussweiler and Schneller's research method to make it more consistent with the professional investment environment: (1) participants were asked to provide an estimate of fundamental value rather than a future price, (2) participants were provided with more detailed and quantitative share descriptions, and (3) fair value estimates were included. While it is believed that these changes successfully improved the ecological validity of the research, the simultaneous implementation of all three changes makes it impossible to identify the underlying cause (or causes) of the different results.

An explanation of the contrasting results would provide anchoring researchers with valuable information on both the anchoring and adjustment process and how the anchoring effect can be debiased. However, in order to identify the primary cause of this difference, the aforementioned changes would need to be implemented in a controlled manner so that only one variable is altered between the new research method and the method used by Mussweiler and Schneller (2003). This would result in at least eight experimental conditions with more conditions needed to identify any interactions between the variables. Unfortunately, this research design was not feasible in the present study due to the large sample it requires. As such, the experimental disentanglement will need to be conducted in future research.

5.5 Behavioural economics education

According to the four auxiliary questions answered at the start of each questionnaire, participants strongly believe that insufficient information on behavioural biases is available to students and investment professionals. Participants gave answers strongly supporting the importance of behavioural economics and training regarding behavioural economics on three of the four questions. The only question in which participants gave an answer not supporting an increase in education on behavioural economics asked how informed participants believed the typical investment analyst is about psychological biases. Most participants considered investment analysts to be either "Mostly uninformed" or "Somewhat informed."

These results will not, however, be interpreted in any depth. Participants consisted of only students at the University of Cape Town and, as such, cannot be considered representative

of the overall population. Furthermore, while the University of Cape Town does offer courses on behavioural economics, for the students surveyed those courses could only be taken in the second semester while the survey was conducted in the first semester. As such, the findings are not surprising. The results were most likely further skewed by a demand effect, since the purpose of the questionnaire was not hidden from participants.

While these problems undermine the external validity of these questions, it is not considered a problem since the questions were only intended to draw participants' attention to the questionnaire and provide participants with easy questions to answer before answering the research question.

6. Conclusion

Research has shown that anchoring and adjustment is a remarkably robust bias. From the earliest experiments by Tversky and Kahneman (1974) to more recent research (e.g. Englich & Soder, 2009; Galinsky et al., 2009), anchoring has shown itself to be remarkably pervasive and resistant to change. This has included research both inside the laboratory (e.g. Epley & Gilovich, 2001) and outside of it (Mussweiler et al., 2000; Northcraft & Neale, 1987). Multiple processes have been proposed to explain these findings but it was only with the theory of selective accessibility (Strack & Mussweiler, 1997) that the robustness of the anchoring phenomenon was explained. A better understanding of the anchoring process resulted in the development of the first successful debiasing technique (Mussweiler et al., 2000) and subsequent research found unexpected limitations which could only be explained by semantic priming (e.g. Englich & Soder, 2009). Even so, most research continued discovering significant anchoring effects in widely varied situations, including the investment environment (Anderson & Settle, 1996; Kaustia et al., 2009; Marsat & William, 2009; Mussweiler & Schneller, 2003).

It is in this context that the present study is situated. The research set out to examine the presence of anchoring and adjustment in a realistic investment context. A further goal was to examine if investors who considered the anchor uninformative would still display a significant anchoring bias. The most significant finding to emerge from the present study was that anchoring may not be as pervasive as previously expected as no significant anchoring effect was found in the sample. This is in contrast with the findings of Mussweiler and Schneller (2003) who found a significant anchoring effect using a similar research design. However, five key differences exist between the present study and the research by Mussweiler and Schneller:

1. The present study asked participants to provide an estimate of intrinsic value rather than a one year target price.

2. The present study used a larger sample.
3. Share descriptions were more detailed and provided the financial information analysts would need to estimate fundamental value.
4. Fair value estimates were included in the present study.
5. The present study included a measure of the informativeness of the anchor.

These changes were intended to make the questionnaire a more realistic representation of the everyday decisions of stock market professionals. While it is impossible to definitively state which of these changes led to the difference in results, evidence from research on multiple anchors suggests that the presence of detailed financial information and fair value estimates might have debiased the anchoring effect in the present study. Furthermore, results from the question on the informativeness of the anchor in the present study shows that a significant part of the anchoring effect described by Mussweiler and Schneller (2003) may have been caused by the conscious and active use of the anchor.

It was further discovered that participants who considered the anchor uninformative showed no anchoring effect. The only participants who showed answers biased towards the anchor were participants who consciously used the anchor and participants who relied on the experimenter-provided valuations. That participants who defaulted to the experimenter-provided valuations showed an anchoring effect implies that all participants were anchored, but that some participants were debiased while others were not. As mentioned, the most likely cause of this debiasing is the presence of multiple anchors which has been linked to a diminished anchoring bias (Switzer & Snizek, 1991).

Together, these findings suggest that the anchoring effect might be less pervasive in the investment environment than previously believed. As conflicting anchors are common in the investment environment, this process of debiasing is likely to occur naturally. More broadly, the results suggest that anchoring can be debiased naturally and automatically and that effortful thought can improve decision making.

However, a number of important caveats must be noted. For one, the sample consisted of finance and actuarial science students rather than professional investors. While this is consistent with most studies on anchoring and adjustment in the investment environment (e.g. Anderson & Settle, 1996; Mussweiler & Schneller, 2003) and while research on expertise suggests that professional investors would be affected similarly (Englich et al., 2006), not using a sample of professional investors does decrease the external validity of the research. A further limitation of the present study is that participants were provided with multiple quantitative valuations rather than asked to calculate them. While this information

would ideally be included in any analysis of intrinsic value, it is unlikely that it always is, and the fewer valuation techniques that are used the fewer anchors are available to debias the anchoring effect. Furthermore, analysts who use the information available on a firm to decide on the most accurate valuation technique might have this decision biased by an anchor found in the initial information.

Even with these limitations, the research findings make significant contributions to our understanding of decision making in the investment environment and the anchoring process. For investors, these findings suggest that anchoring is less likely to bias their decisions than previously believed. While this finding is important, as no practical debiasing technique has been discovered for investors and no steps are currently taken to avoid the anchoring bias in investment situations the immediate implications for investors are small. Perhaps the most significant contribution for investors is that the focus of future research is shifted away from research on debiasing the anchoring effect in investment situations to research examining the presence and mechanisms of the anchoring bias in realistic investment situations. For social scientists, these findings are more important. Firstly, the research highlights many shortcomings in our current understanding of the anchoring process. Secondly, the research provides important information on the anchoring mechanism, specifically with regards to effortful thought and the presence of multiple anchors. As such, and in line with the exploratory nature of the study, the present research provides an important platform for future research.

As the findings from the present study contradict the findings from other, similar experiments (e.g. Mussweiler & Schneller, 2003), the most important topic for future research is a repeat of the present study. By repeating the study, researchers will be able to see whether the results were caused by the given factors or by extraneous variables. While it is possible for the sample and research conditions to have affected the results, this explanation seems unlikely as an anchoring bias has been found consistently, regardless of the conditions or sample used. Should a repeat of the present study obtain similar findings, it would highlight the need for additional research into the anchoring process.

An important way in which the anchoring process should be examined is regarding the interaction between the anchoring process and multiple anchors. To date, few studies have examined how anchoring affects judgements when multiple anchors are present. Ariely et al. (2003) tested the effect of multiple anchors but their anchors were presented consecutively instead of concurrently. Closer to the present study was research by Switzer and Sniezek (1991) where participants were provided with two anchors concurrently. The researchers found a significantly decreased anchoring effect. According to Switzer and Sniezek (1991),

this decrease could be caused by a decrease in the probability of participants anchoring on the manipulated anchor and through a dilution of the anchoring effect due to the multiple anchors. However, these mechanisms have not been tested. Should they be shown to exist, it would imply that many anchoring effects are automatically debiased due to the volume of anchors encountered in everyday life. Further studies should focus on determining how the quality, rather than the quantity, of additional anchors affect anchoring and adjustment (Whyte & Sebenius, 1997). As was argued in the present study, the quantitative valuations might be considered higher quality anchors than the salient past share price and, as a result, might nullify the anchoring effect. However, to date no research has tested the effect of the quality of an anchor on the anchoring effect. Future research should play an important role in clarifying the relationship between the quality and quantity of anchors and the anchoring effect.

The interaction between effortful thought on the anchoring effect also requires additional research. Most research on anchoring and adjustment has suggested that effortful thought and increased elaboration are positively correlated with an anchoring effect (Chapman & Johnson, 1999; Epley & Gilovich, 2005). However, this only appears to be true when increased elaboration does not enable participants to narrow the range of possible answers or lead to new information inconsistent with the anchor. For example, Wright and Anderson (1989) found that participants who were motivated to consider a question in greater depth showed a smaller anchoring effect. Their questions lent themselves more to systematic calculation in which case effortful thought could reduce the potential range of answers. It is believed that in the present study, participants who showed greater elaboration were more likely to evaluate all anchors, thus debiasing the anchoring effect. In order to test this, more research on the relationship between effortful thought and the anchoring bias should be conducted.

As the present study highlights, experimental findings cannot always be applied directly to non-experimental settings. This is especially important for investors, where the complexity of investment decisions differs significantly from the controlled environment maintained in experiments. As such, more research should be done testing the anchoring effect in a realistic investment environment. An important addition to the anchoring research on investors would be the inclusion of a large sample of professional investors. To date, no study has had a significant sample of investors and a realistic investment setting: Mussweiler and Schneller (2003) used only twenty professional investors for their research while Kaustia et al. (2008) had a large investor sample but tested them using the classic anchoring paradigm. While most research on expertise suggests that the results would be unaffected by sampling professional investors (Englich & Mussweiler, 2001), it is possible that students

use naïve processes that differ significantly from investors (as suggested by Anderson and Settle, 1996). Furthermore, research by Moody and Soder (2009) argues that experts might show a larger anchoring effect than participants low in expertise. This could prove significant in studies, such as the present one, where no anchoring effect was detected. Unfortunately, obtaining a large sample of professional investors has proven to be difficult and very time consuming.

The effect of different types of anchors found in the investment environment should also be researched. Current share price has been shown to act as an anchor (Marsat & Williams, 2010) but this was done without including a measure of informativeness. As the present study showed, the anchoring effect can often be explained by the conscious use of an anchor even when the anchor should be normatively uninformative. To add to this, different types of anchors have different properties which could affect the anchoring bias. For example, the current share price would be a more relevant comparison standard than a past share price and might thus result in an anchoring effect even when multiple other anchors are presented. A share trend, on the other hand, might not result in an anchoring effect even when no other anchors are included, as a result of anchor-target incompatibility (Tversky, Sattath & Slovic, 1988). Research on these topics would do more than simply test the limits of anchoring in the investment environment—it would provide valuable information on the anchoring process and its limitations in general.

A final topic for further research is debiasing techniques in the investment environment. As was argued in the literature review, the techniques designed to debias anchoring and adjustment would not be useful in the investment context (for example, Mussweiler et al., 2000). In order to improve investment decision making, viable debiasing techniques should be investigated. However, it is felt that debiasing techniques should be secondary to testing the presence of the anchoring bias in investment situations and the anchoring process. Until it can be shown conclusively that an anchoring effect occurs in a realistic investment situation with a sample of professional investors, doing research on debiasing methods might prove redundant.

Appendix A – Investors' Questionnaires

Low anchor questionnaire



UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Share valuation questionnaire

Expected duration: 10–15 minutes

Number of questions: 6

Dear Participant,

Thank you for participating in this study. The research is being conducted as part of a Master's thesis at the University of Cape Town.

The aim of the research is to examine the presence of behavioural biases in professional investors in South Africa. The presence of these biases has been demonstrated internationally, but not in South Africa. Being aware of these biases in investment situations will allow researchers to identify ways to ameliorate their effects.

The survey consists of six questions: Four on the importance of behavioural finance education in South Africa and two related to share valuation. In order to answer the valuation questions you will need to read through the information from a sell-side analyst's share report before providing your best estimate of the share's future value. The survey is expected to take between ten and fifteen minutes.

All responses to this survey are completely anonymous and will not be used for any purpose outside of the present study. Participation in this study is voluntary, and the survey has been approved by the Faculty of Commerce Ethics in Research Committee.

If you have any questions about the survey or the research, please send them to stefan@2sparrows.co.za.

Sincerely,
Stefan Els

Section A

1. How much do you believe investment decisions are affected by psychological biases?
 - (a) Not at all
 - (b) Slightly
 - (c) Moderately
 - (d) Significantly

2. How informed or uninformed do you think the typical investment analyst is about behavioural biases in the investment environment?
 - (a) Uninformed
 - (b) Mostly uninformed
 - (c) Somewhat informed
 - (d) Well informed

3. How important is information on investment biases to you?
 - (a) Not important
 - (b) Slightly important
 - (c) Moderately important
 - (d) Very important

4. Do you believe that finance students are provided with enough information on biases in the investment environment?
 - (a) No
 - (b) Yes

Section B

Please read through the following description of a share before providing your best estimate of intrinsic value.

AB Foods

Company Background

AB Foods is a consumer packaged-goods company. It is an important player in the South African food sector and has expanded its business to include personal care products. AB Foods' products are mostly distributed through major retail stores, but some products are distributed through exclusive health stores. Products are sold primarily in South Africa (SA) with a few products being distributed in emerging markets.

While the South African economic recovery has been slow, growth in disposable income, due to current and expected future real wage increases, should support continued growth in earnings in the future, especially in health foods and personal care products. The current low interest rate environment has also contributed to superior earnings growth. However, earnings growth in the food sector will be negatively affected by food inflation coming off of recent highs. Unless rising operating costs can be controlled or passed on by AB Foods it will further depress margins. AB Foods has come off a recent low of 446c.

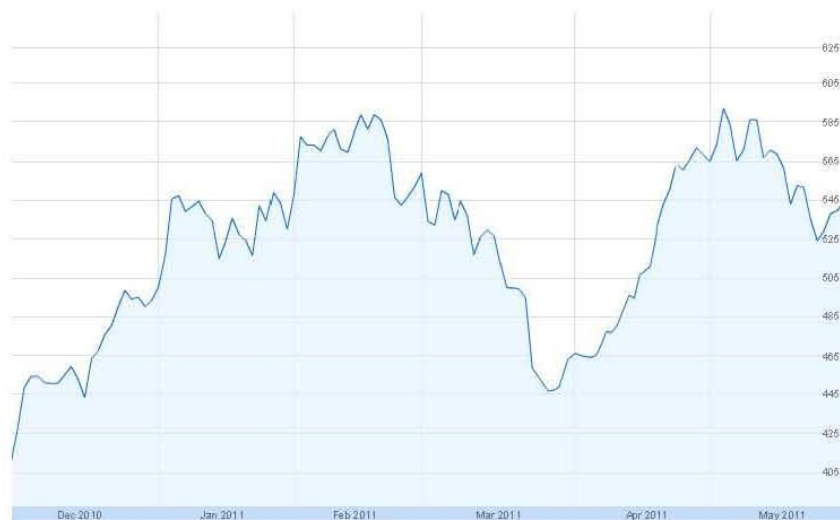


Figure 1: AB Foods Price History

At face value companies in this sector appear expensive. They are trading above their historical average P/E rating (c15x compared to the historical average of c11x) and at a premium to the market. However, the very strong performance over the last 12 months has led to a re-rating of the sector. A further rerating could be justified given the lower risk free rate and the continued acceleration in earning momentum in the coming months. Food processors have tended to outperform the market in a downturn, but show weaker performances relative to the market in an upturn.

Analysis of financial data

The following data, based on the information from AB Foods and the food processors sector, was used in the valuation of AB Foods:

Summary of Valuation Data	
P/E ratio – trailing	14.01
Historical average share P/E ratio – trailing	11.24
Current sector average P/E ratio – trailing	15.27
EPS – current	40.18
DPS – current	10.01
Risk free rate – current 10 yr SA Govt Bond Yield	8.25%
Beta – Food Processors Sector	0.44
Market Risk Premium – estimate	5.6%
Free Cash Flow to Firm (FCFF) – trailing	9.91
Free Cash Flow to Equity (FCFE) – trailing	7.09

Table 1: Financial data used in share valuation

For the Dividend Growth model, a long run rate of growth of dividends of 8.7% was obtained by the averaging of two separate estimates: A top-down growth rate estimate of 9.1% derived from an expected inflation rate of 5.5% and a real GDP growth rate of 3.4%; and a bottom-up sustainable growth rate of 8.3% which is calculated as the product of the company's retention rate of 75% and seven-year average return on equity of 11.1%.

Fair Value Estimates	
Dividend Growth Model	546.23
FCFF Method	587.27
FCFE Method	522.81
Average valuation	552.10

Table 2: Valuations provided by different models

5. What is your best estimate of AB Foods's intrinsic value? Give your answer in cents.

Share valuation questionnaire

6. How much did the past price peaks and troughs on the stock chart affect your estimate of intrinsic value?
- (a) Not at all
 - (b) Slightly
 - (c) Moderately
 - (d) Significantly

Thank you for participating in our survey. If you have any further questions or comments, please send them to stefan@2sparrows.co.za

High anchor questionnaire



UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

Share valuation questionnaire

Expected duration: 10–15 minutes

Number of questions: 6

Dear Participant,

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The survey consists of six questions: Four on the importance of behavioural finance education in South Africa and two related to share valuation. In order to answer the valuation questions you will need to read through the information from a sell-side analyst's share report before providing your best estimate of the share's future value. The survey is expected to take between ten and fifteen minutes.

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Stefan Els

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 - (c) Moderately
 - (d) Significantly

2. How informed or uninformed do you think the typical investment analyst is about behavioural biases in the investment environment?
 - (a) Uninformed
 - (b) Mostly uninformed
 - (c) Somewhat informed
 - (d) Well informed

3. How important is information on investment biases to you?
 - (a) Not important
 - (b) Slightly important
 - (c) Moderately important
 - (d) Very important

4. Do you believe that finance students are provided with enough information on biases in the investment environment?
 - (a) No
 - (b) Yes

Section B

Please read through the following description of a share before providing your best estimate of intrinsic value.

AB Foods

Company Background

AB Foods is a consumer packaged-goods company. It is an important player in the South African food sector and has expanded its business to include personal care products. AB Foods' products are mostly distributed through major retail stores, but some products are distributed through exclusive health stores. Products are sold primarily in South Africa (SA) with a few products being distributed in emerging markets.

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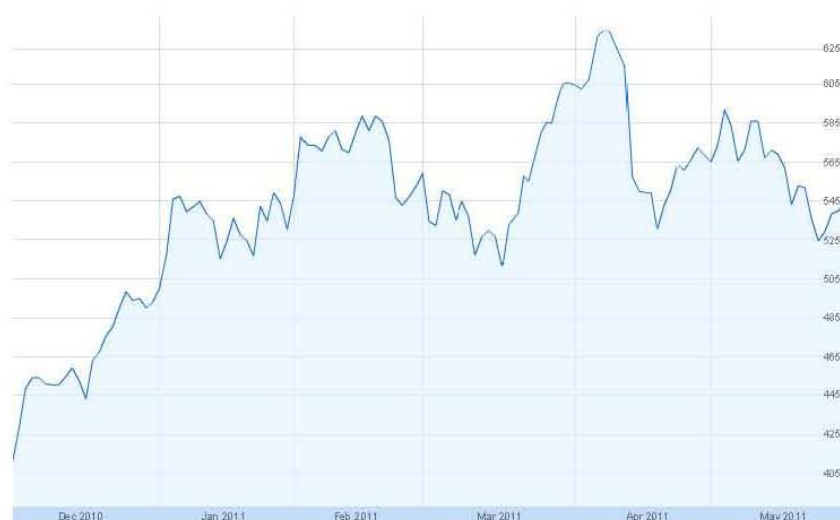


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 - (d) Significantly

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